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AN EVALUATION OF RISK METRICS FOR FUTURE IMPLEMENTATION OF THE MARINE CORPS ENTERPRISE RISK MANAGEMENT PROCESS

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AN EVALUATION OF RISK METRICS FOR FUTURE IMPLEMENTATION OF THE MARINE CORPS ENTERPRISE RISK MANAGEMENT PROCESS

by

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June 2020

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This research reviewed current Marine Corps risk management processes and methodologies to identify best practices that can be incorporated into the planned enterprise risk management (ERM) implementation so time and cost could be reduced, estimates improved, and outcomes better aligned with organizational goals and objectives. To achieve these objectives, this research conducted an analysis of the current literature, recommended process improvements, and identified risk metrics that can be used in the ERM process.

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LIST OF ACRONYMS AND ABBREVIATIONS

CAPE	Cost Assessment and Program Evaluation
CBO	Congressional Budget Office
CD&I	Combat Development and Integration
CMC	Commandant of the Marine Corps
COSO	Committee of Sponsoring Organizations of the Treadway Commission
CPG	Commandant's Planning Guidance
CPIB	Capability Portfolio Integration Board
CPRB	Capability Portfolio Review Board
DoD	Department of Defense
DOE	Department of Energy
DoN	Department of the Navy
DPG	Defense Planning Guidance
DRRS	Defense Readiness Reporting System
ERM	Enterprise Risk Management
FMFIA	Federal Managers' Financial Integrity Act
FOS-MADIS	Marine Air Defense Integrated System – Family of Systems
FY	Fiscal Year
GAO	U.S. Government Accountability Office
G/ATOR	Ground Air Task Oriented Radar
GPRAMA	Government Performance and Results Act
HQMC	Headquarters Marine Corps
ISO	International Organization for Standardization
JFO	Joint Fires Observer
JROC	Joint Requirements Oversight Council
MCCA	Marine Corps Capability Area
MCCL	Marine Corps Capability List
MCDA	Multi-Criteria Decision Analysis
MCPC	Marine Corps Program Code
MICP	Managers' Internal Control Program

MRB	MROC Review Board
MROC	Marine Requirements Oversight Council
NDD	National Defense Directive
NDS	National Defense Strategy
NPS	Naval Postgraduate Group
OMB	The Office of Management and Budget
OMTES	Organize, Man, Train, Equip, and Sustain
PA&E	Program Analysis and Evaluation
P&R	Programs and Resources
PEB	Program Evaluation Board
POM	Program Objective Memorandum
PPBE	Planning, Programming, Budgeting, and Execution
PRB	Program Review Board
SECDEF	Secretary of Defense
SECNAV	Secretary of the Navy
SME	Subject Matter Expert
T/POM	Tentative-POM
TSA	Transportation Security Administration
USMC	United States Marine Corps

I. INTRODUCTION

Since its inception in a Pennsylvania tavern two and a half centuries ago, the Marine Corps has been the nation's "force in readiness" always prepared to face any threat and carry out any mission the nation requires. As one might expect, the requirements, missions, policies, and procedures for how the Marines conduct business have been evolving and adapting ever since. In fact, one of the Corps' mottos is to "adapt to and overcome adversity," something Marines take great pride in and demonstrate frequently. Some of the challenges faced over the last two hundred and forty-five years were evolving mission tactics between the World Wars where the Marines became the premier amphibious assault element among U.S. forces, redefining strategic objectives post World War II, and more recently the development of counterinsurgency and counter-improvised explosive device tactics developed in support of Operations Iraqi and Enduring Freedom. The only constant throughout all of this has been the Marines' regular adaptation to new policies, environments, and directives which at times required divestment of old and outdated programs and policies. The Commandant of the Marine Corps, General Berger said as much in his Commandant's Planning Guidance (CPG) in 2019 when he said, "We cannot continue to accept the preservation of legacy capabilities with little to no demand signal, or those that are only being retained in support of surge requirements associated with the least-likely, worst-case scenario. Capabilities and force elements meeting this criteria are candidates for divestment." (Berger, 2019a, p. 15). What the Commandant is saying here is that the way forward requires new and improved methods for determining the best programs for future development while also identifying those that no longer benefit the Marine Corps.

The latest reformation requiring Marine Corps adaptation is the call for an enterprise risk management methodology requested by the Government Accountability Office (GAO) and reinforced by the Secretary of the Navy (SECNAV) and Commandant of the Marine Corps (CMC). In OMB circular A-123 the GAO directed, "The policy changes in this Circular modernize existing efforts by requiring agencies to implement an Enterprise Risk Management (ERM) capability coordinated with the strategic planning and

strategic review process established by Government Performance and Results Act Modernization Act (GPRAMA), and the internal control processes required by Federal Managers' Financial Integrity Act (FMFIA) and Government Accountability Office (GAO)'s Green Book" (OMB, 2016, p. 1). The idea is that better accountability and oversight is needed to determine how funds are allocated and what risk is associated with regard to the allocation of more funding for one program vice another. The GAO goes on to say,

> Successful implementation of this Circular requires Agencies to establish and foster an open, transparent culture that encourages people to communicate information about potential risks and other concerns with their superiors without fear of retaliation or blame. Similarly, agency managers, Inspectors General (IG) and other auditors should establish a new set of parameters encouraging the free flow of information about agency risk points and corrective measure adoption. An open and transparent culture results in the earlier identification of risk, allowing the opportunity to develop a collaborative response, ultimately leading to a more resilient government. (OMB, 2016, p. 2).

Historically, the system for financing the military has operated via policies that funded units and programs based on historical trends while raising or decreasing budgets was based on new initiatives, missions, and manning levels. While this has worked in the past to a degree, it hasn't provided the level of fidelity necessary for congress and the taxpayers to truly know what their money is going towards and whether it is being spent efficiently or not.

In his Commandant's Planning Guidance (CPG), General Berger states, "Every activity within Headquarters Marine Corps (HQMC) must support the POM build and inform the planning, programming, budgeting, and execution (PPBE) process. Our current structures and processes fail to meet this standard." (Berger, 2019a, p. 6). With the proposed implementation of the enterprise risk management methodology the veil of uncertainty can finally be lifted and the Marine Corps can truly improve its efficiency and fiscal stewardship to a level that the taxpayers demand and deserve. If not only for the sake of clarity and openness, this new policy should also provide the Marine Corps with the ability to improve mission readiness and efficiency while also more effectively developing

new programs and initiatives that will enable it to raise the bar even higher. The CMC elaborates on this point in his 2019 CPG by saying,

> In the summer of 2023, when we anticipate a routine transition to a new Commandant, we will have accomplished the following, at a minimum: Re-established our primacy within the Department as the most innovative and revolutionary thinkers, the most well-disciplined and accountable force, and the most transparent and responsive force to our collective civilian leadership across the Joint Force and Department. (Berger, 2019a, p. 23)

Clearly, the leader of the Marine Corps has a vision of his force which includes adapting the methods of enterprise risk management into the daily business of the Corps. The basic concepts of being able to assess what risks are associated with divesting in certain programs as well as what benefits are achieved in fulling funding others are right in line with what the Commandant was seeking from his Marines.

A. BACKGROUND

So what is ERM and how can it be implemented in the Marine Corps? Simply put, enterprise risk management is a method that informs decision-makers as to what risks and benefits lie among different courses of action. It has been growing and gaining popularity since the late 1990s and early 2000s throughout the corporate world and private industries around the globe. It is also something similar to how the military already conducts business. For years the Marine Corps has been using and improving upon its operational risk management (ORM) program which influences everything from major exercises and operations to basic safety checks before Marines go on leave. In a 2007 report the author, Chris Johnson, expounds on this idea saying, “Risk management provides the most important single framework for strategic, tactical and operational decision making across the U.S. Military. Composite Risk Management (CRM) has been introduced to guide decision making across the U.S. Army in training, combat and peacekeeping operations as well as off-duty activities.” (Johnson, 2007, p. 1). Understanding that ERM is not an entirely foreign methodology will be important as the program comes online and is implemented down the ranks.

When implemented and incorporated into the culture of organizations, ERM has made business successful and more efficient across the board. In a 2018 article on implementing ERM in government organizations, Springer (2018) describes the process as "the management of risks across the organization to enable an agency to achieve their strategic objectives. Agencies need to inventory all risks that might have substantial impact on their performance and achievement of objectives. Agencies need the ability to identify and address key risk areas and the agility to quickly respond" (p. 1). The description she uses for ERM falls right in line with the goals and objectives laid out by the CMC in his 2019 CPG discussed earlier. The ability to identify the risks coupled with an increased ability to quickly respond to shifts in priorities and initiatives is essential for how the Marine Corps conducts business. To be a true "force in readiness" the Marines have to be able to adapt to changes in policies from the government and the ever-changing strategic threats of the world. With a solid understanding of our programs, capabilities, and readiness while also being mindful of the impacts that occur when funding is altered the Marine Corps will be better positioned to meet its mission goals and objectives. Additionally, in the same article, Springer says, "A successful manager in government must not only master previously developed performance management tools, but also must now formally and rigorously address an increased number of uncertainties." (p. 1). The uncertainties mentioned correlate to both risk uncertainties in the Marine Corps and budgetary and funding uncertainties associated with the annual National Defense Budget passed by Congress each year. In order to be able to react in a timely fashion and to appropriately modify funding allocations to units and programs the Marine Corps needs to embrace this ERM process and fully incorporate it down to the lowest levels. How this is going to be done successfully will be analyzed as part of the research in this paper.

Some of the Benefits historically associated with ERM are discussed by Jim Keiser in a 2013 article in which he says,

> Organizations often find that ERM programs provide a combination of both qualitative and quantitative benefits. While there are many benefits to ERM, let's focus on five of them. benefit one: creation of a more risk focused culture for the organization. benefit two: standardized risk reporting. benefit three: improved focus and perspective on risk. benefit four: efficient use of resources. benefit five: effective coordination of regulatory and compliance

> matters. Through all of the benefits noted above, ERM can enable better cost management and risk visibility related to operational activities. (p. 1).

Of the five listed benefits the most relevant to the Marine Corps' implementation of ERM is definitely the fourth, "efficient use of resources." As mentioned previously, the goal of having this system in place is being able to understand more thoroughly how funding will impact the Marine Corps resources and readiness levels. While this is already being done at the tactical and operational levels, by incorporating an ERM system the strategic decision-makers who ultimately decide the fate of funding levels will now be included in the process and be better able to ensure priorities and capabilities are met. Gone are the days of funding programs, units, and operations with little explanation as to what benefits are provided and what risks are associated with failure.

To be effective, ERM, must identify and assess risks relevant to mission accomplishment. OMB (2016) defines the objectives of effective ERM as the following:

- creates and protects value;
- is an integral part of all organizational processes;
- is part of decision-making;
- explicitly addresses uncertainty;
- is systematic, structured, and timely;
- is based on the best available information;
- is tailored and responsive to the evolving risk profile of the Agency;
- takes human and cultural factors into account;
- is transparent and inclusive;
- is dynamic, iterative, and responsive to change; and
- facilitates continual improvement of the organization. (p 9)

Most of the listed elements above will be relatively straightforward when incorporating ERM into Marine Corps budget outlooks; however, there will be some areas where determining precisely what negative impacts will result from lower funding levels will not be simple and will require subject opinions from subject matter experts and unit commanders. These will be the toughest parts of this process and require some very hard decisions.

So what might this look like? In Figure 1, OMB provides an illustrative example of what an enterprise risk management model looks like as well as a description of what the seven steps of the model mean.

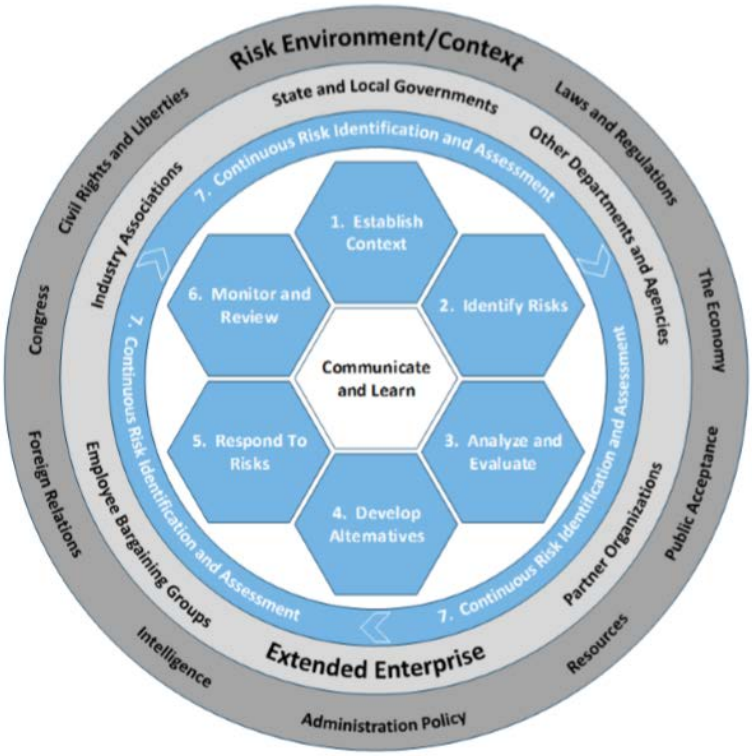

Figure 1. Illustrative Example of an Enterprise Risk Management Model. Source: OMB (2016).

1. **Establish the Context** - understanding and articulating the internal and external environments of the organization.

2. **Initial Risk Identification** - using a structured and systematic approach to recognizing where the potential for undesired outcomes or opportunities can arise.

3. **Analyze and Evaluate Risks -** considering the causes, sources, probability of the risk occurring, the potential positive or negative outcomes, and then prioritizing the results of the analysis.

4. **Develop Alternatives** - systematically identifying and assessing a range of risk response options guided by risk appetite.

5. **Respond to Risks** - making decisions about the best option(s) among a number of alternatives, and then preparing and executing the selected response strategy.

6. **Monitor and Review -** evaluating and monitoring performance to determine whether the implemented risk management option(s) achieved the stated goals and objectives.

7. **Continuous Risk Identification/Assess** - must be an iterative process, occurring throughout the year to include surveillance of leading indicators of future risk from internal and external environments. (OMB, 2016, p.11)

The 7th step should look familiar to many Marines as it mirrors the targeting cycle and many assessment diagrams that are used by most of the U.S. military organizations. It also seems to embody Boyd's observe orient decide and act (OODA) loop ideology that so many military organizations have adapted and used over the years (Hightower, 2020). By following this diagram and the recommended procedures within these methods will assimilate nicely into the Marine Corps culture.

B. TERMS AND DEFINITIONS

The term enterprise risk management is defined by OMB Circular no. A-123 as,

> a series of coordinated activities to direct and control challenges or threats to achieving an organization's goals and objectives. ERM is an effective Agency-wide approach to addressing the full spectrum of the organization's external and internal risks by understanding the combined impact of risks

> as an interrelated portfolio, rather than addressing risks only within silos. ERM provides an enterprise-wide, strategically-aligned portfolio view of organizational challenges that provides better insight about how to most effectively prioritize resource allocations to ensure successful mission delivery. (OMB, 2016, p. 9)

Clearly, a holistic ERM approach to analyzing risk throughout the Marine Corps will provide the tools and methods necessary for improving budget allocations while also ensuring mission goals and objectives are still met.

While similar, the Government Accountability Office (GAO) (2016) defines ERM as, "a forward-looking management approach that allows agencies to assess threats and opportunities that could affect the achievement of its goals." (p. 1). While a more simple analysis of ERM, the GAO definition focuses on the forward-looking element of the process which is an essential piece needed by the Marine Corps in order to stay ahead of future fiscal constraints and changes to mission requirements. Staying ahead of the unknown requires a thorough understanding of your organization and how changes made will affect capabilities.

Breaking down the elements of ERM for this research, the International Organization for Standardization (ISO) 31000:2018 defines risk as an "effect of uncertainty on objectives" (ISO, 2018, para. 1). Important to the Marine Corps definition is the severity of associated risks coupled with the probability of the occurrence of certain risks. These are the essential pieces of information Marine Corps decision-makers will require when making critical assessments.

For this paper, the term, *Marine Corps decision makers* will refer to the CMC, the assistant CMC, and their advocates spread throughout the various Marine Corps organizations and commands. The general officers included here are the ones whom will rely on the new ERM methodologies when making decisions, creating policies, and allocating resources that affect Marine Corps programs and initiatives.

C. OBJECTIVE OF THIS STUDY

This research reviews current Marine Corps risk management processes and methodologies to identify best practices that can be incorporated into the planned enterprise

risk management (ERM) implementation where time or cost could be reduced, estimates improved, and outcomes made more impactful. To achieve these objectives this research analyzes the current methods and procedures, recommends process improvements, and identifies ways to determine what the risks are associated with funding decisions and how they can be used in the future ERM process. During the conduct of this research it was identified that the Marine Corps system for risk analysis was lacking a decent way to assess probabilities associated with risks as well as a measurable way to link these risks to organizational goals and objectives. By adding these elements into the process, the risk analysis will better be able to provide decision makers with a clear idea of what programs to divest in and which to fully fund. Additionally, through methods outlined in this research creating a probability distribution from risk impact statements will further increase accuracy of risk assessments and ensure the Marine Corps postures itself for success in future conflicts.

D. SCOPE

This study identifies viable methods for eliciting risk probabilities associated with impact statements as well as techniques for creating probability distributions that can be used during the development of the ERM process but will not go into the various approaches to multi-criteria decision-making.

E. ORGANIZATION OF THE STUDY

This study contains four chapters organized in the following manner:

- Chapter I consists of the introduction and background of the enterprise risk management methodology and a brief overview as to how and why it is important to the Marine Corps way of conducting business.
- Chapter II consists of a review of the literature included during the conduct of this study and will analyze how each source provided support for the research questions and the conclusions drawn.

- Chapter III contains a review of data from several Marine Corps Program Codes as well as an analysis of what probabilities are associated with certain metrics of risk and how that will be evaluated in the future Marine Corps ERM model.

- Chapter IV concludes the research conducted during this study and provide analysis regarding the findings for the implementation of the Marine Corps' ERM model. Additionally, this chapter will recommend any future research that may be conducted on this topic.

II. LITERATURE REVIEW

The following chapter analyzes and describes the articles referenced for the conduct of this research based on relevance and support. The articles are broken down by type, theories and issues discussed, findings and conclusions, quotes referenced, and finally a description of how each supports the overall research questions. Incorporating this literature review into the paper provides fidelity and understanding as to why articles were referenced, how they support the research, and where to find the information for follow on research. This is essential to establishing a sound foundation of support for justifying how the study was carried out and providing support to conclusions drawn.

A. ERM GUIDANCE AND GOVERNANCE RELEVANT TO USMC

There have been many policies and memorandums published over the years relating to ERM and the concept of risk management which are pertinent to the development and implementation of this process to the Marine Corps. The first was Title 10, Section 5063 of the United States Code (U.S.C.) written in 1956 defines the roles and responsibilities of the United States Marine Corps. It describes the mission of the Marine Corps as follows: "The Marine Corps shall be organized, trained, and equipped to provide fleet marine forces of combined arms, together with supporting air components." (Armed Forces, 1956). The inclusion of this article enables the readers and follow-on researchers to better understand what is required of the Marine Corps and to ensure that as research is conducted and methods of evaluating risk recommended that those recommendations are aligned to Marine Corps goals and objectives. Part of carrying out this mission requires that the Marine Corps ensure its' mission readiness and that its' forces have the required manning and technological support to defeat any adversary on the battlefield. This goal will be best supported by the development of an enterprise risk management methodology for allocation and disbursement of resources and funding which when implemented will ensure the funding and support of the essential programs to achieving success.

Providing guidance and direction to the Marine Corps every year is the Commandant's Planning Guidance which provides strategic direction to all Marines and

subsequently reflects the goals and objectives of the Secretary of Defense as laid out in the Defense Planning Guidance. This provides Marines with direction for planning and operations throughout the organization and ensures subordinate efforts and objectives are aligned to the Marine Corps' overall mission. Essentially, it enables the Commandant to tell his subordinates his commanders' intent for the year, which will then be relayed and reflected in subordinate units down the chain of command. It was referenced and included in the research because it provides the direction for the organization and supports the theory that greater fidelity and understanding is required in how risks are evaluated and assessed at the highest levels of the Marine Corps. In this document the Commandant calls on his Marines to focus efforts on modernization and force design while ensuring support to HQMC in building the Program Objective Memorandum (POM) in the most effective manner possible. In doing so the Marines will have a solid understanding of what the future operating environment might look like while also keeping pace with developing threats from near-peer competitors. Processes and efforts recommended in this guidance will only be truly realized with the implementation of the ERM process at all levels. The decisions the Commandant focuses on require decision-makers to have a clear understanding of the risks involved in the resource and funding allocations for the organization which happens to be one of the benefits of an ERM process.

In 2016, The Government Accountability Office authored a document on enterprise risk management which included a detailed analysis of what ERM was and how it could be used as well as an in-depth overview of what organizations had adopted the methodology within the government at that time. Also included in the article was the varying explanations and reasons for why each organization needed to implement an ERM process. Some of the essential benefits of ERM were that it allows management to understand an organization's portfolio of top-risk exposures, that it recognizes how risks interact, and that it encompasses all areas where an organization is exposed to risk. (GAO, 2016). While these definitions and explanations facilitate the overall understanding of ERM the most important aspect of this document was its mandate to all government agencies to begin the implementation of an ERM process from the top down.

Detailing what ERM is at its core is the next document researched for this paper, written by the International Organization for Standardization (ISO) in 2018 on risk management guidelines. This literature provided a detailed breakdown of what risk management is at a basic level which enabled further development and understanding of enterprise risk management methodologies. This was incorporated into the terms and definitions section of this paper and will also be beneficial during the development of an ERM process for the Marine Corps as its broad principles and framework can be easily adapted to many different systems of risk management.

In OMB Circular A-123, the memorandum directs managers to modernize their policies and procedures to include an enterprise risk management capability coordinated with the strategic planning and strategic review process established by the Government Performance and Results Act Modernization Act (GPRAMA), as well as internal control processes required by the Federal Managers' Financial Integrity Act (FMFIA) and GAO's Green Book. (OMB, 2016). The idea here is to provide directives that engages all agency management in order to improve mission delivery, reduce costs, and focus on risk mitigations in key areas of concern. Successful implementation of this policy will enable government agencies to spend wisely while focusing expenditures and efforts in areas where they will provide the most benefit. This relates directly to the research being conducted in this paper just as the GAO memorandum did by directing the initiation and implementation of an ERM process throughout the government in order to increase efficiency and compliance both operationally and financially.

B. ERM IN THE PUBLIC SECTOR—CASE HISTORIES RELEVANT TO USMC

It is worth noting that the initial development and genesis of the ERM process came out of the public sector and in the following section key studies and papers relevant to the Marine Corps that have been referenced during the course of prior research by Patrick McElroy are mentioned here. A complete and thorough analysis of the works in the public sector was conducted by McElroy in his 2019 thesis titled *Identifying Key Meta-Narrative Themes Across Public-Sector Enterprise Risk Management Literature in Support of the Marine Corps Future Implementation*. In this work the author delves deep into the history

and origins of ERM and provides detailed analysis as to which are pertinent to the course of future development of a Marine Corps ERM and to this research. As it was already covered in depth, only the summary is included here. In his research, McElroy (2019) stated,

> This research synthesized those factors from the literature that characterized successful ERM in public-sector institutions into four meta-narrative themes: (1) Create and Sustain a Risk Culture, (2) Governance and Infrastructure, (3) Have a Plan, and (4) Constructive and Continuous Communication. Also, this research synthesized those factors from the literature that characterized challenges with implementing and sustaining ERM into two meta-narrative themes: (1) Organizational Culture Change, and (2) Endogenous and Exogenous Pressures. Finally, this research synthesized those factors from the literature that characterized the value of ERM into two meta-narratives: (1) Support to Strategic Decision-Making, and (2) Enables Compliance with Regulations. (p. 71).

While many of these themes and findings are an essential part of this research, the background laid out by McElroy will be referenced here as it built the foundation for the follow-on research conducted in this paper. How this all relates to the Marine Corps Planning Process (MCPP) is also mentioned in McElroy's work,

> Parallels can be drawn between the Marine Corps Planning Process (MCPP) and the greater planning-execution-assessment continuum, and ERM. There exist similarities between the characteristics that make ERM successful in public-sector organizations and MCPP successful in the Marine Corps. For example, both processes require visible and active support from leadership, which includes their participation, to be successful. Both processes require a common langue understood by all to be successful. Furthermore, both processes require a focal point for coordination and must be aligned with the organization's goals and objectives. (2019, p. 72).

In summary, the development of ERM for the Marine Corps should not be seen as some foreign concept that is going to revolutionize the way of thinking in the organization as much as an amalgamation of present practices and methods into a more refined and definitive risk analysis methodology.

C. METHODS OF RISK MANAGEMENT RELEVANT TO USMC

Over the last two decades, as it grew in popularity and evolved to different industries, ERM developed several unique methodologies and characteristics which were referenced in this research and will be reviewed in this section. In 2015, Dinwoodie et al. wrote a research paper titled, *Evaluating strategic opportunity costs: a multidisciplinary approach to affordability analysis,* in which they assess the affordability of critical Marine Corps weapon system acquisitions in light of budgetary reductions and resource constraints. The researchers concluded that their

> capital-planning methodology would help the Department of Defense (DoD) and other governmental agencies to understand the concept of investment affordability, especially when return on investment is not well defined. This method allows any institution to allocate scarce resources between competing programs that have many different constituencies with different perceptions of value. (Dinwoodie, 2015)

The analysis drawn here mirrors closely that of OMB in that the Marine Corps needs to implement new and improved tools for making those tough resource allocations and divestment decisions. Nearly a decade before the use of ERM was mandated a paper was written detailing the process of applying ERM to military organizations and forecasting likely adverse impacts that would need to be overcome for it to be effective and successful. The paper was titled *Paradoxes of military risk assessment* and was written by C.W. Johnson from the University of Glasgow. For the purpose of this research, this article was beneficial in that it provided an insight into the proposed negative impacts that this implementation could have. Most experts have been talking about the benefits of the ERM process and how its use would improve the allocation of resources and risk mitigation, but few, if any, had discussed what difficulties would arise from fitting this process into military organizations. While conducting research into the application of ERM into the Marine Corps, many of the concerns delivered in this article will need to be addressed and considered if the process is to succeed.

A 2019 government report written in support of the Program Objective Memorandum 21 (POM-21) risk assessment was the Force Management Risk Assessment Report authored by J. Sanchez. It developed,

> an assessment framework to examine the risk associated with failing to develop and maintain Title X responsibilities for organizing, manning, training, equipping, and sustaining Marine Forces. Maintaining these Title X responsibilities or capabilities enables the Marine Corps to generate and sustain sufficiently trained and ready forces to meet Combatant Command (CCMD) requirements. (p. 1)

This report lays some foundational groundwork for the research being conducted in this paper and will enable a better understanding of methods currently being utilized to assess risk which will provide direction for how the incorporation of ERM in the Marine Corps should work best.

The *Five Benefits of Enterprise Risk Management*, written by Jim Kreiser in 2013 provides an in-depth synopsis of the benefits one can expect to achieve through the implementation of ERM in any organization. It broadly applies the principles and methods of ERM to management practices that are universally applicable throughout the corporate realm and the government sector. The specific benefits, as discussed in chapter one, help managers and decision-makers to refine and develop the framework for their own implementation of ERM in their respective industries. For the purpose of this paper, the guidance provided enables a smoother transition and some solid advice while working toward an ERM methodology that will succeed in today's Marine Corps.

In 2018, Springer wrote an article on *Implementing Enterprise Risk Management in Government* which provided a thorough understanding of what ERM is, how it is applicable to government and military organizations, as well as a brief overview of how to begin implementing it into these types of agencies. In the article she states,

> Agencies need to change the role and objective of the risk function and structure in an agency. Strong and attentive agency managers are needed to integrate risk and performance management. At the same time, risk experts need to become trusted advisors for line managers. This often requires a change of management principles and governance structure. In addition, management processes at the strategic, tactical and operational levels need to receive sufficient risk support in goal setting, planning, performing and evaluating efforts. (para. 8)

The last part regarding support for all levels down the chain of command during the implementation phase is key and will definitely need to be included in any strategy

going forward. The whole culture of the Marine Corps will need to adapt to the new system and in order for that to be successful the leaders at the top will need to provide the tools and support mechanisms that will enable the junior leaders and subordinate users to make the transition. This article is not just applicable to the research in this paper but really has insight and solid concepts that I incorporate into proposed solutions in the conclusion.

D. METHODS OF PROBABILITY ELICITATION RELEVANT TO USMC

In 2005, at the very earliest stages of the development of ERM, a group of statisticians collaborated on a paper examining statistical methods for eliciting probability distributions. The article reviewed "how people represent uncertain information cognitively and how they respond to questions about the information" (Garthwaite, 2005, p. 680). If an effective ERM process is to be developed for the Marine Corps it will, at its core, have to address the biases that are inherently held by individuals providing risk impact analysis. The path to succeeding here lies in a firm understanding of the concepts and methods explored and developed in this research and others that followed. A couple of years later, further research conducted on probability elicitation yielded a method for "constructing a distribution from statements that have been elicited from experts." (Oakley and O'Hagan, 2007). The idea behind this methodology is to determine trends and likelihoods behind expert opinions and statements in order to better understand the risk impacts and associated probability of occurrence. For many in the Marine Corps, risk assessments and impact statements, expert opinion and analysis are required to truly understand and account for risks associated with required decisions on funding or resource allocations. By being able to incorporate ideas such as those proposed by Oakley, the Marine Corps will have a more refined process with improved results.

Another essential element of the risk impacts needed for ERM is the ability to determine uncertainty associated with expert inputs. Without incorporating uncertainty, results will generally be overly optimistic and inaccurate. (Teter, 2019). Through the inclusion of the decision maker's risk aversion through risk-based optimization, while also accounting for uncertainty of unknown parameters, Teter demonstrated a 20% improvement versus the original "naïve" method. A method for addressing the uncertainty

of impacts associated with risk analysis in the Marine Corps is discussed and demonstrated in the analysis of this research. Other concerns that must be addressed when dealing with expert opinion analysis deal with cognitive and motivational bias. In a paper written in 1975 Carl Spetzler and Alex Holstein defined these as,

> The sources of bias can be classified as motivational or cognitive. Motivational biases are either conscious or subconscious adjustments in the subject's responses motivated by his perceived system of personal rewards for various responses. In other words, he may want to influence the decision in his favor by giving a particular set of responses. Or he may want to bias his response because he believes that his performance will be evaluated by the outcome. Even when a subject is honest—in the sense that he lacks motivational biases—he may still have cognitive biases. Cognitive biases are either conscious or subconscious adjustments in the subject's responses that are systematically introduced by the way the subject's responses that are systematically introduced by the way the subject intellectually processes his perceptions. For example, a response may be biased toward the most recent piece of information simply because that information is the easiest to recall. Cognitive biases, therefore, depend on subject's modes of judgment. (p. 345)

From reviewing past data and inputs collected by the Marine Corps it is easy to see some of each of these biases. The challenge faced for future iterations of data collection is to identify a method for reducing this as much as possible in order to get the most honest and correct forecasted risks. In addition to biases Spetzler discusses anchoring as another tendency for subject matter experts when providing inputs. In the paper Spetzler defines anchoring as,

> The most readily available piece of information often forms an initial basis for formulating responses; subsequent responses then represent adjustments from this basis. For example, the current business plan is often used as an available starting point. Likewise, when predicting this year's sales, the subject may use last year's sales as a starting point. He may use the recent years with the biggest and smallest sales as the bases for formulating judgments about the extreme values for this year's sales. The initial response in an interview often serves as a basis for later responses, especially if the first question concerns a likely value for the uncertain quantity. (p. 346)

The biggest issue with anchoring is that most experts adjustments for future expectations and events are often insufficient and tend to mirror the prior events too closely. Ways to deal with this would be following up on the previous year’s estimates and

expectations, tracking what actually occurred, and then comparing that to the provided expectations from that year to develop a trend analysis and improve follow on estimates. While data to this point is insufficient with a process that is still being developed, future efforts will be able to follow this advice and improve the process each year.

One last method relevant to this research was proposed by Schlag in 2015. In his paper, he proposed the use of a "most likely interval" when eliciting expert opinions. He describes this process as, "Our payment method incentivizes of the expert to select a "most likely interval", where any event inside the interval is at least as likely to occur as any event outside the interval. It features an adjustable parameter to influence the width of the reported interval." (p. 456). Essentially, he takes expert inputs for multiple events and then has the same experts estimate the likelihood of their outcomes against each other to determine an interval where one event becomes most likely and the others less likely or not likely at all. This method can be a very capable method for the Marine Corps' development of ERM and will be discussed and incorporated into the research in chapter 4.

E. SUMMARY

This chapter reviewed and analyzed methods of risk analysis in the public and government sectors, government guidance and regulations of risk analysis procedure, as well as techniques for eliciting probability from experts during the collection of risk impacts. All of this analysis was included assuming it is relevant to the Marine Corps' objective of developing an ERM methodology in the future. This chapter lays out the foundation upon which the analysis can now be conducting in the ensuing chapters of this paper.

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III. METHODOLOGY

This chapter introduces the methodology, models, and assumptions used in the analysis phase of the research. This is done by reviewing previous approaches to measuring risk and then applying the probability elicitation techniques to those methods in order to refine the process and improve the measures of risk. The purpose of using this method is to answer the following questions:

- What risk assessment capabilities does the Marine Corps currently utilize that could be included in an ERM methodology?
- How is data required for other purposes that might be relevant to ERM acquired, cleansed, and utilized?
- How does the Marine Corps elicit probabilities that can be used to assess risk impacts and outcomes and how should they measure and visualize the risks in a Marine Corps enterprise risk management process?

A. RELEVANT METHODS AND TECHNIQUES FOR USMC

Analyzing previously provided risk metrics and analysis is the first step in being able to develop a more thorough ERM methodology that will incorporate the probability that risks will occur and the severity that those risks carry. In a 2018 paper about probability elicitation the author, Michael Teter stated,

> Capital budgeting optimization models, used in a broad number of fields, require certain and uncertain parameters. Oftentimes, elicited subject matter expert (SME) opinion is used as a parameter estimate, which does not always yield perfect information or correspond to a single value. (p. 189)

This statement directly relates to issues currently experienced in the Marine Corps as large scale risk analysis requires expert opinions regarding risk to force and mission if funding levels change. Much of the current process is strictly looking at the consequences of decreased funding and has no probability assessment at all. For risk assessments to provide an accurate portrayal, the likelihood or probability of the consequences must be

elicited and incorporated into the process which will then open the door to further statistical analysis later on. Another possible option for the elicitation of expert opinions is the Most Likely Interval (MLI) method proposed by Schlag (2015). In his paper, Schlag recommends, "Our method, called the Most Likely Interval elicitation rule (MLI), asks the expert for an interval and pays according to how well the answer compares to the actual outcome" (p. 456). Here, the idea is that the expert provides a likely range of outcomes for any given scenario vice a single impact. By expounding on the possible outcomes and providing more of a range of likelihoods the subject matter experts enable decision-makers to base funding and allocations on more sound information thereby increasing the chance that the right decisions are made. While Schlag recommended paying experts for their opinions and inputs in the business sector, the military would simply rely on the accuracy of the inputs with the key benefit being increased accuracy of risk impact statements over the provided interval range. It will be up to military leaders to instill in their subject matter experts the belief that the quality of inputs they provide to this process is essential for the Marine Corps to function at its best and to be successful in the battlefield. It may seem that that battlefield victories and doing tasks associated with ERM are not related, but that couldn't be further from the truth. The 360 Marine Corps Program Codes (MCPCs) in the Marine Corps cover everything from weapons acquisitions to unit funding and manning. Every single program code is relevant to the overall success and must be appropriately analyzed and resourced.

An interesting method for developing solid risk projections for ERM was studied by Oakley (2007) and is referenced in his paper titled *Uncertainty in Prior Elicitations: A Nonparametric Approach*. In this paper, he talks about developing a distribution of likelihoods from prior expert statements and outcomes. By looking at what experts had previously stated and then assessing what actually occurred he proposes a mathematical approach to develop future probabilities for potential risks and outcomes. This approach could definitely contribute to a Marine Corps ERM process and provide a more accurate measure for risk probabilities. A possible approach to developing this would be to have researchers look at past years' risk impact statements as provided to the Marine Corps Program Review Information Management Enterprise (MCPRIME) SharePoint site and

review the risk impact statements and likely outcomes provided by subject matter experts. Then they can check to see what funding levels were supported to see if full funding requirements were met. For those that were not met they can see what percentage of funding was provided and match that up with the closest risk impact statements. Once complete with these steps they can engage with these experts for follow up analysis to determine what actual impacts occurred as a result of the decreased funding and then measure that against what had been provided previously. Additionally, to further verify the impacts, researchers could review unit reports in the Defense Readiness Reporting Systems (DRRS), which in many cases may align the mission of the units or MCPCs with the expected impacts from decreased funding. This may actually provide a more authoritative estimate as the reports are very detailed and provide descriptive analysis of unit readiness, shortfalls, and strengths. If analysis in this manner is carried out on a large enough sample population a pattern should begin to emerge and using Oakley's methodology a probability distribution for future risk impacts can be devised. While the scope of this paper doesn't allow for this research to be conducted, future researchers can definitely pursue this approach and begin working up a satisfactory model for this process.

Finally, one last method discussed by Garthwaite in his 2005 paper involves asking a sequence of questions regarding the likely outcomes or impacts and then requires the experts to weigh the likelihoods of the impacts against the others to determine which is more or less likely to occur. In this paper he says the following about the "bisection method",

> A method of bisection is often used that entails a sequence of questions of the following form:
>
> - Q1. Can you determine a value (the expert's median) such that X is equally likely to be less than or greater than this point?
> - Q2. Suppose you were told that X is below your assessed median; can you now determine a new value (the lower quartile) such that it is equally likely that X is less than or greater than this value?
> - Q3. Suppose you were told that X is above your assessed median; can you now determine a new value (the upper quartile) such that it is equally likely that X is less than or greater than this value?

> An advantage of this line of questioning is that only judgements of equal odds are required, an intuitively easier task than specifying percentiles that divide a probability in the ratio of say, 4:1. (p. 685)

This method of eliciting multiple inputs from experts and then determining the likelihood of each occurring when weighed against other possible outcomes is a viable option for eliciting probabilities for risk statements and is discussed more during the analysis phase of the research in chapter 4. In addition to asking questions in the above manner it is equally important that the questions asked are familiar and meaningful to the experts. Garthwaite (2005) suggested, "As a guiding principle, experts should be asked questions about quantities that are meaningful to them. This suggests that questions should generally concern observable quantities rather than unobservable parameters, although questions about proportions and means also might be considered suitable, because psychological research suggests experts can relate to these quantities." (p. 689). From reviewing the methods and techniques currently in use by the Marine Corps to assess risk it is clear that this idea is already being used for some of the impact analysis, but does stand to be improved. If the meaningful data provided can be asked in a way that creates parameters that will provide a probabilistic likelihood, this would help create data that can then be analyzed statistically, further increasing the accuracy of the risk estimates.

The methods, techniques, and ideas discussed in this section will be further explored and demonstrated during the analysis phase of the research in chapter 4 and will be followed by a recommendation for improvements and conclusions in chapter 5.

B. MODEL

Developed for the purpose of this research, Figure 2 is an illustrative framework for how ERM could work in the Marine Corps.

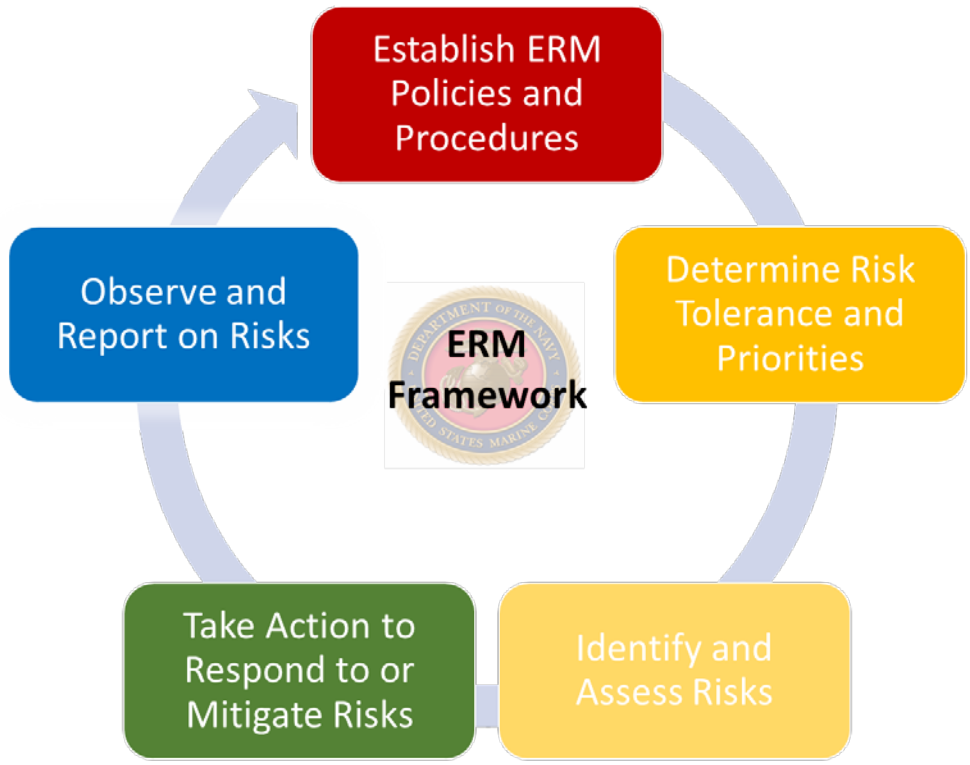

Figure 2. Illustrative Example of Enterprise Risk Management Framework for Marine Corps.

1. Enterprise Risk Management Model

The five steps, set up in a circular pattern because they will repeat over predetermined intervals, are as follows:

a. Establish ERM Policies and Procedures

This process requires the Marine Corps to analyze and develop the best version of an ERM process for the organization. In doing so, the program will need to account for all Marine Corps Program Codes (MCPCs) under the Program Evaluation Boards (PEBs) and try to determine how risks can be best represented and analyzed for each. The difficulty here lies in the variety of programs and their unique missions, goals, and objectives. Some programs may be in the acquisition realm and the goal may be to produce a given number of weapons or vehicles, while others could be training programs, units, and manning initiatives. Determining how to understand what risks are associated with decreased funding and resources is the first step in ensuring the ERM process is effective. Once the

"how" is understood, the policy can be officially developed and passed down to all units and programs.

b. Determine Risk Tolerance and Priorities

The second step will require engagement from the top down to all subordinate units and programs in the Marine Corps. To determine risk tolerance decision-makers must first understand what the risks are for a given scenario, i.e., funding cuts of 2%, 5% or 10%. Prior to receiving input from the MCPCs regarding risks, a thorough analysis of mission essential tasks and priorities must be conducted to develop a firm understanding of where funding cuts could impact units or programs. Without an analysis of tasks and priorities, it is possible that many of the risks submitted may be highest-priority initiatives vice bottom of the list expendable options. The idea here is that when a unit is told it is being cut 2% of its budget, it isn't going to immediately stop performing its highest priority mission and will more likely cease executing some mission or task from the low end of the list instead. By acquiring the listed objectives ahead of the risk impacts the decision-makers can ensure that impacts accurately reflect what will occur if lower levels of funding become reality. Once priorities have been provided decision-makers must assess their tolerance levels for programs and units. This will enable them to be able to clearly and concisely address identified risks in the next step and more quickly decide how to proceed with the required decisions.

c. Identify and Assess Risks

Following the receipt of the listed tasks and priorities, decision-makers will need to receive inputs regarding the aforementioned impacts associated with decrease funding and resources for given MCPCs. In addition to these inputs they will also need to determine some sort of probability associated with given risks and impacts in order to have a more accurate and robust model of risk. This will provide a detailed account of what is expected if allocation adjustments are required for given MCPCs. Some examples are units reducing their end strength or readiness levels given a funding cut or decreased allocation of some resource or an acquisition program reducing the number of vehicles they plan to acquire that year given lower funding levels. There is an enormous variety of different complex

situations that will result for each of the MCPCs and understanding these situations is necessary to make informed decisions that will benefit the organization.

d. Take Action to Respond to and/or Mitigate Risks

At this point in the process all inputs have been received and assessed for the priorities, risks, and tolerance levels. Now the decisions must be made whether to accept the risks, change the allocation to eliminate undesirable impacts, or to initiate a mitigation strategy to lessen the impacts associated with the plan. Some examples of this include increasing planned lifespan of current vehicles if the production of replacements are delayed or maybe planning exercises at home bases when unit funding is reduced and large scale exercises are cut. Obviously, both of these situations still come at a cost whether it be increased maintenance requirements or decreased personnel readiness, but the overall risk impacts are reduced.

e. Observe and Report on Risks

Risk assessment is an ongoing process that does not end at any given step. It requires constant vigilance and evaluation to stay fully aware of the risks and their evolution throughout the process. By staying on top of risk assessment MCPCs and decision-makers will be better prepared to restart the process once the current phase completes and the cycle begins anew. One way to ensure this is occurring could be periodic risk assessment reviews that can be submitted in the same way the initial risk impacts are. This will enable the higher headquarters to stay abreast of any issues as they arise vice waiting until the budget submission is due. This step in the ERM process roles over to the beginning of a new cycle where the next year's risks, priorities, and tolerance levels will be determined and evaluated.

C. SUMMARY

This chapter discussed the methods and approaches used in risk analysis and probability elicitation that are used in this paper during the analysis phase. During this analysis, a review of current Marine Corps methods of risk assessment will be conducted as well as an in depth breakdown of what improvements will be helpful in developing an

ERM process. By following the tested and proven techniques laid out above, the research conducted during this paper provides the Marine Corps a solid framework from which essential risk analysis procedures can be developed and practiced.

IV. ANALYSIS

A. CURRENT APPROACH

The current approach used by the Marine Corps to analyze risk associated with funding MCPCs requires subject matter experts (SMEs) or MCPC managers to login to the Marine Corps Program Review Management Enterprise (MCPRIME) website and provide detailed inputs, impacts, and analysis. This process gathers information on the purpose of the program, funding programmed and executed, as well as the current issues and estimated future conflicts if funding is reduced. The questions asked are broad in scope due to the fact that all MCPCs must fill in the same responses and programs vary drastically from one to the next. With several hundred MCPCs, it would be unfeasible to create specific queries for each program. With that in mind, the responses received also vary greatly with some programs providing very detailed and equitable inputs and others less detailed and more biased responses. For the purpose of this research, examples from several different MCPCs from several different Program Evaluation Boards (PEBs) are being evaluated in order to ensure a decent range of inputs are reviewed and any recommendations developed for this research will be able to reference specific programs and impacts. The five MCPCs included in this paper are Staff and Operations Support HQMC, Semper Fit and Recreation, Joint Fires Observer (JFO), Marine Air Defense Integrated System Family of Systems (FOS-MADIS), and Ground/Air Task Oriented Radar (G/ATOR). The first part to review is the questions asked of the SMEs that contribute to the development of risk impacts.

1. MCPC Risk Questions and Instructions

In the MCPRIME system, each MCPC SME is asked to respond to the following inquiries:

- If your MCPC receives a 2% cut over the FYDP, enter how you would prefer that cut to occur that would minimize negative impact to your MCPC and the Marine Corps enterprise. Since they are reductions, enter the cuts as negative numbers. You should only consider cuts to your DISCRETIONARY funding only, even though the 2% cut is from your

total programmed amount. The reduction should be present across the FYDP (i.e., do not take all 2% out of one year; distribute the bill across all five years in the FYDP to help us balance the potential bill). Note that if you currently do not have programmed funding in the FYDP, put in your recommended cuts, but it does not necessarily have to equal 2% to validate in the MCPRIME. (USMC, 2020).

- If your MCPC receives a 5% cut over the FYDP, enter how you would prefer that cut to occur that would minimize negative impact to your MCPC and the Marine Corps enterprise. Since they are reductions, enter the cuts as negative numbers. You should only consider cuts to your DISCRETIONARY funding only, even though the 5% cut is from your total programmed amount. The reduction should be present across the FYDP (i.e., do not take all 2% out of one year; distribute the bill across all five years in the FYDP to help us balance the potential bill). Note that if you currently do not have programmed funding in the FYDP, put in your recommended cuts, but it does not necessarily have to equal 5% to validate in the MCPRIME. (USMC, 2020).

- If your MCPC receives a 10% cut over the FYDP, enter how you would prefer that cut to occur that would minimize negative impact to your MCPC and the Marine Corps enterprise. Since they are reductions, enter the cuts as negative numbers. You should only consider cuts to your DISCRETIONARY funding only, even though the 10% cut is from your total programmed amount. The reduction should be present across the FYDP (i.e., do not take all 2% out of one year; distribute the bill across all five years in the FYDP to help us balance the potential bill). Note that if you currently do not have programmed funding in the FYDP, put in your recommended cuts, but it does not necessarily have to equal 10% to validate in the MCPRIME. (USMC, 2020).

The SMEs are provided the following guidance prior to providing their risk impacts:

- Instructions: Enter the effects on your program if your current FYDP programmed funding is reduced by 2%, 5%, and 10%. We are asking for simplified PBIS load level data in order to streamline the process if we are asked to pay a bill on short notice. You may add additional lines from decision packages by clicking on the blue square with the white triangle "Repeating Table" button. Keep in mind that you should include reductions on your DISCRETIONARY funding only. (USMC, 2020).

- We recommend that you not write the same assessment for each percentage reduction profile - doing so undermines the validity of the assessment. (However, we understand that the risk compounds, so referencing the risk incurred at lower reductions is acceptable.) (USMC, 2020).

- Internal Risk Assessment: We understand that this assessment is subjective in nature and that you - as a MCPC manager - have been tasked to defend your MCPC and its funding. However, we ask that you look at the risk assessment from a PROGRAM PERSPECTIVE, keeping in mind the Commandant's Guidance and other force development directives. (USMC, 2020).

- Risk to Mission: Ability to execute assigned missions at acceptable human, materiel, financial, and strategic cost.

    - Minor (1-3): Very likely (80-100%) achievement of objectives for future operations and contingencies.

    - Moderate (4-5): Likely (50-80%) achievement of objectives for future operations and contingencies.

- Major (6-7): Questionable (20-50%) achievement of objectives for future operations and contingencies.
- Extreme (8-9): Unlikely (0-20%) achievement of objectives for future operations and contingencies.

- Risk to Force: Ability to recruit, man, train, equip, and sustain the force to meet strategic objectives.
  - Minor (1-3): Risks are completely mitigated by existing USMC capabilities; no loss to personnel / equipment.
  - Moderate (4-5): Risks are partially mitigated by existing USMC capabilities; minimal loss to personnel / equipment.
  - Major (6-7): Risks are partially mitigated by existing USMC capabilities; significant loss to personnel / equipment.
  - Extreme (8-9): Risks cannot be mitigated by existing USMC capabilities; grave loss to personnel / equipment.
- Risk Analysis:
  - Enter the specific Decision Package that the reduction impacts
  - Describe the exact impact to your MCPC
  - Quantify the impact severity from 1 (low) to 9 (high)

The instructions and questions included in this section provide a decent understanding of the risk impacts associated with reducing funding for different programs. Though some are better than others and there are a few that don't provide anything of value and simply list their MCPC as essential and requiring full funding. Additionally a key element in risk analysis missing in these assessments is the inclusion of probability. At the moment the inputs provided are short succinct impact statements stating that if funding is reduced the only possible outcome is to cut "blank" from the program or delay

development of this. In risk assessment, the inclusion of probability helps to create a more accurate assessment by looking at all possible outcomes and weighing the likelihood of each against the others. This probability measure and greater range of impacts would be very beneficial in providing more accurate assessments of the expected risks.

2. MCPC Risk Statements and Inputs

The next step in the research is to look at the provided responses for each of the five MCPCs reviewed and determine which were good and which ones fell short of the mark.

a. Effects of the 2% Reduction

Staff Operations and Support HQMC: Staff Ops & Support programs that have funding deficiencies are DMCS Staff Agencies (to include G10, EOS & GOS), DoN Tracker, Mass Transit, Inspector General, Travel Missions (Aviation and the Commandant), Information Technology, Operations and Fiscal Management, Logistics and Publishing, Records Management, HROM/EEO, SJA, Security Programs, and the PA&E Analytical Contract which ends in FY22. Impact severity 7 (major). (USMC, 2020).

Semper Fit and Recreation: This reduction would eliminate funding for Outdoor and Recreation Programs. Most installations will be forced to reduce services or close operations. The elimination of the entire health promotion program and the loss of 15 FTEs which includes education and support across seven core areas including performance nutrition, injury prevention, and tobacco cessation. Installations would no longer provide support to Marines and families in areas including nutrition and weight management, injury prevention, tobacco cessation, sexual health and responsibility, and preventable diseases. In FY19, there were 9,992 classes and briefs for 44,986 Marines and family members; 763 customer outreach activities; 5,372 one-on-one consults with Marines and family members; 16,334 collaborative activities for 148,621 Marines and family members. Impact severity 5 (moderate). (USMC, 2020).

Joint Fires Observer: A 2% reduction risk is manageable if executed at the two EWTGs from an instructor cadre standpoint. A 2% reduction at MRDET Ft. Sill would impact the required 2:1 Student/Instructor ratio (required during simulations); whereby, the 2% reduction equates to the loss of ~ one (1) instructor and a 25% decrement to the 4-man instructor cadre. Impact severity 1 (minor). (USMC, 2020).

Marine Air Defense Integrated System – Family of Systems: A 2% reduction reduces the number of systems by (3) which equates to 3 LAAD sections (1 Platoon). This will impact deploy to dwell ratios for Marine Expeditionary Unit (MEU) support and inhibit UDP deployment. Risk to Mission: MADIS full operational capability (FOC) delayed by one year. Fleet unable to support deploy to dwell ratio of MEU and Unit Deployment Program (UDP). Risk to Force: FMF units not defended from attack by manned/unmanned aircraft and missiles. Impact severity 4 (moderate). (USMC, 2020).

Ground/Air Task Oriented Radar: Risk is moderate, especially in FY22. However, not implementing the cut-in of PCSP in the production line in FY22 misses out on the opportunity to improve G/ATOR emplacement/displacement times at half the cost of having to perform the desired retrofit upgrade in the future. Emplacement/ displacement times (KSA G/ATOR Block2) are paramount as a system/force survivability and maintaining pace with the force. Impact severity 4 (moderate). (USMC, 2020).

b. Effects of the 5% Reduction

Staff Operations and Support HQMC: Staff Ops & Support programs that have funding deficiencies are DMCS Staff Agencies (to include G10, EOS & GOS), DoN Tracker, Mass Transit, Inspector General, Travel Missions (Aviation and the Commandant), Information Technology, Operations and Fiscal Management, Logistics and Publishing, Records Management, HROM/EEO, SJA, Security Programs, and the PA&E Analytical Contract which ends in FY22. Impact severity 8 (extreme). (USMC, 2020).

Semper Fit and Recreation: This reduction would eliminate funding for Outdoor and Recreation Programs. Most installations will be forced to reduce services or close operations. The Semper Fit Parks, picnics and playground program would be eliminated to include 32 FTEs. Installations would lose all funding for the maintenance of beaches, pavilions, trails and outdoor recreation areas. This would reduce services for recreational swimming for Marines and families at open water sites, creating an increased risk at those open water sites. Impact severity 5 (moderate). (USMC, 2020).

Joint Fires Observer: A 5% reduction equates to a 43% reduction in class scheduling/throughput at MARDET Ft. Sill and approximately 33% reduction at the EWTGs. Impact severity 4 (moderate). (USMC, 2020).

Marine Air Defense Integrated System – Family of Systems: A 5% reduction in funds reduces the number of systems by 7 LAAD Sections.

This will impact deploy to dwell ratios for MEU support and inhibit UDP deployment. Risk to Mission: FOC of LAAD modernization / fielding of FMF Counter-UAS capabilities delayed by one year. Risk to Force: FMF units not defended from attack by manned/unmanned aircraft and missiles. Impact severity 6 (major). (USMC, 2020).

Ground/Air Task Oriented Radar: Task Oriented Radar Program of Record Risk is moderate and includes the above 2% risk as well. At a minimum, G/ATOR plans for one minor and one major software release per year. Missing a major software release will negatively impact both system readiness and mission capability in FY22. Impact severity 5 (moderate). (USMC, 2020).

c. Effects of the 10% Reduction

Staff and Operations Support HQMC: Staff Ops & Support programs that have funding deficiencies are DMCS Staff Agencies (to include G10, EOS & GOS), DoN Tracker, Mass Transit, Inspector General, Travel Missions (Aviation and the Commandant), Information Technology, Operations and Fiscal Management, Logistics and Publishing, Records Management, HROM/EEO, SJA, Security Programs, and the PA&E Analytical Contract which ends in FY22. Impact severity 9 (extreme). (USMC, 2020).

Semper Fit and Recreation: Installations will no longer be able to offer services provided by the Health Promotion Program, which will negatively impact Marines and their families in areas such as performance nutrition counseling, injury prevention, and tobacco cessation. Installations will no longer be able to offer Cat B aquatics programs which included guarded open water areas and recreational swimming at installation pools which would negatively impact Marines and their families. There will be increased risk at open water sites. Community Centers and associated programming will be eliminated. All Command and Community Special Events will be eliminated which would impact the relationship between military facilities and the surrounding civilian communities. Impact severity 5 (moderate). (USMC, 2020).

Joint Fires Observer: A recommended COA would be to levy the entire 10% reduction onto the contractor instructor cadre at MARDET Ft. Sill; thereby, prioritizing JFO seats to the FMF. Marine 0802 Artillery Officers undergo JFO training during the MAOBC (not part of the POI) are qualified but not certified, which would occur in the FMF if assigned as a JFO. Impact severity 6 (major). (USMC, 2020).

Marine Air Defense Integrated System – Family of Systems: A 10% reduction of funds reduces the number of systems by 15 LAAD Sections (3

Platoons) Risk to Mission: FOC of LAAD modernization / fielding of FMF Counter-UAS capabilities delayed by two years. Risk to Force: FMF units not defended from attack by manned/unmanned aircraft and missiles. Impact severity 8 (extreme). (USMC, 2020).

Ground/Air Task Oriented Radar: A 10% reduction will impact both the procurement of one system and the ability to stand-up a complete IROAN capability at the Depot. FOC will not be achieved without a future payback with potentially a significant increase in unit cost. Impacts Operational Availability of systems in the Fleet due to increased turnaround time to perform IRON of each system. Impact severity 6 (major). (USMC, 2020).

3. MCPC Risk Statement Analysis

When reviewing the impact statements provided above it is clear that there is a wide range in the quality of answers and details provided. Some impact statements are the same for each level of forecasted cuts while others provided in depth detailed impact statements and even list out the specific numbers of individuals who would be impacted if the program was cut. This level of fidelity may be slightly unrealistic to require across the board as many of the programs simply don't have that capability or don't provide similar services, but it does seem that the quality of responses and impacts should be equivalent across the board.

Some impact statements with great detail included the G/ATOR responses which detailed specific system elements that would not be available if funding was cut further enabling decision makers to determine if the risk is worth the reward. The Staff and Operations Support HQMC responses provided very detailed background issues including funding deficits that have been plaguing the program for 6 years and that already have them operating at minimum capacity and capability. While this is important information for decision makers and will most certainly be weighed into the calculus, it shouldn't encourage the exclusion of impact statements for possible funding cuts. Only with the most complete information can decision makers know what is expected to occur if additional funding cuts take place. Even if the resulting impacts are considered insurmountable and detrimental to the survival of the organization, that information and the details within these statements must be communicated up the chain of command for the Marine Corps to make informed decisions regarding the risk associated with funding allocations.

Another set of MCPC responses that stood out were those from the Joint Fires Observer MCPC. Their impact statements lay out a detailed analysis of how many instructors would be reduced for their course and then expound on how that affects the course size and student throughput they are able to accommodate. They also incorporated a technique of providing ranges of impacts for their 5% capacity estimation by stating, "Result in the loss of one (1) to two (2) contracted instructors from the total contractor instructor cadre of twenty (20), spread across three formal schools." (USMC, 2020). The idea of creating a range of impacts or an interval of possible outcomes is one that is tied to probability elicitation literature in many instances. The concept increases the chances that the proposed impacts in the range of forecasts occur vice the previous method where one possible outcome is predicted and no other feasible impacts are considered. There is almost always more than one likely outcome for any given scenario and to only consider one decreases the chances that it actually comes to fruition. Given the pervasiveness of uncertainty, a range of potential impacts is both more realistic and insightful than providing a single impact.

Another tendency is responses was taking the 2% reduction and assigning it the highest priority decision package as the likely impacts affected first. This is an unrealistic expectation as the first thing that should be cut should be the lowest priority element or package. The only logical explanation for cutting the highest priority decision package is that it accounts for more than 98% of the budget and taking the monetary cut in this decision package is the only option and therefore the least painful; However, it is likely that this is not the actual situation. Rather, what is more likely happening is the MCPC respondent is attempting to influence the macro process of how a 2% reduction is absorbed across all Marine Corps MCPCs. The logic that seems to arise from a whereby associating the funding cuts with the highest priority element that is essential for the program, the program managers are hoping that decision makers won't want to accept that impact and decide not to reduce their funding. This scenario occurs in the FOS-MADIS MCPC statements where for each of the cuts they assign their top priority decision package, "MADIS Increment I Programmed" to receive the cuts before any of the other five lower priority packages. Hopefully, however, this is not the case and there are more relevant

explanations for the thought process behind these risk impacts. A summary of the issues seen in the data collected for this research is summarized below in Table 1.

Table 1. MCPC MCPRIME Statements and Analysis Table

MCPC	**Priority Rankings**	**Impacts**	**Aligns Impacts & #1 DP**
FOS-MADIS	Done correctly	Sufficient detail	Yes (requires justification)
G/ATOR	Done correctly	Very detailed	Yes (requires justification)
S&OS HQMC	All listed #1	None provided	None Provided
SF&R	Lots of Duplicates	Very detailed	No
JFO	Done correctly	Very detailed w/ ranges	Only have 1 DP

Table 1 is a detailed breakdown of repeating issues seen in data collected from the five MCPCs reviewed for this paper. The first column describes how the decision package rankings were completed with some being done as instructed and others listing all of them the same. Column two is a brief description of how thorough the risk impact statements are. Here the impacts ranged from very detailed statements to some providing none at all. Finally, column three highlights which MCPCs align their top priority decision package with their first experienced risk impact.

While understanding that not all MCPCs are created equal and that there exists quite extraordinary differences in their program requirements and missions one thing that can be done to improve the quality of the risk impact forecasts that was mentioned above is the development of more robust statements that account for probability impacts from high to low. Just how this can be accomplished is discussed in the next section.

B. PROPOSED APPROACHES

1. Approach I: Likert Scale Probabilities

As was mentioned in earlier chapters the introduction of probability elicitation methods to this process will provide an increased range of likely outcomes increasing the accuracy of the risk estimation statements and giving decision makers a more precise picture for what impacts would look like if cuts were to proceed. The next question to answer is how to make this happen.

The first step in the new approach is to rework the MCPRIME questions and instructions in a way that encourages MCPC managers to provide more robust responses with a range of impacts. One way to reword the MCPRIME questions is through the following:

Instead of the present statement, "If your MCPC receives a 2% cut over the FYDP, enter how you would prefer that cut to occur that would minimize negative impact to your MCPC and the Marine Corps enterprise. Since they are reductions, enter the cuts as negative numbers. You should only consider cuts to your DISCRETIONARY funding only, even though the 2% cut is from your total programmed amount. The reduction should be present across the FYDP (i.e., do not take all 2% out of one year; distribute the bill across all five years in the FYDP to help us balance the potential bill). Note that if you currently do not have programmed funding in the FYDP, put in your recommended cuts, but it does not necessarily have to equal 2% to validate in the MCPRIME." (USMC, 2020).

Rephrase to, "If your MCPC receives a reduction in funding of 2% over the FYDP, provide at minimum two possible impacts that the program would experience and then rate the likelihood of each outcome on a scale from most likely to least likely to occur. Understanding that there are always multiple ways that funding reductions can impact programs and budgets, providing this range for your MCPC will enable a more precise understanding of just how your program could possibly be affected. You should only consider cuts to your DISCRETIONARY funding only, even though the 2% cut is from your total programmed amount. The reduction should be present across the FYDP (i.e., do not take all 2% out of one year; distribute the bill across all five years in the FYDP to help us balance the potential bill). Note that if you currently do not have programmed funding in the FYDP, put in your recommended cuts, but it does not necessarily have to equal 2% to validate in the MCPRIME."

2. Examples of Approach I

In order to better understand how this works, examples have been provided for each of the five MCPCs reviewed for this paper. The responses below are created by the research from the inputs MCPC managers provided in prior year statements and are theoretical statements that would be expected for a 5% reduction:

a. Joint Fires Observer Example (See Table 2)

A 5% reduction in funding could lead to the following:

(1) Result in the loss of one (1) to two (3) contracted instructors from the total contractor instructor cadre of twenty (20), spread across three formal schools.

(2) The loss of one (1) contractor reduces the capacity in the aggregate by approximately two (2) JFO classes and associated student throughput by 10% or approximately 38 students.

(3) The loss of two (2) contractors reduces the capacity in the aggregate by approximately three (3) JFO classes and associated student throughput by 15% or approximately 58 students.

(4) The loss of 3 contractors reduces the capacity in the aggregate by approximately four (4) JFO classes and associated student throughput by 20% or approximately 76 students.

(5) 5% reduction risk and loss of 2 instructors would be manageable, if occurring at the EWTGs. A 5% reduction at MARDET Ft. present a greater impact on maintaining the required 2:1 student/instructor ratio during course simulations; whereby the 5% reduction as well as representing a 50% decrement to the 4-man instructor cadre.

Provided inputs could then be fed into the a table, as is seen in Table 2 below, providing MCPC managers an opportunity to rate the likelihood of each outcome on a Likert scale.

Table 2. Joint Fires Observer Likert Table (Approach I)

For each of the statements, circle the response that most closely approximates the likelihood of the event, where: 1 = Very Unlikely, 2 = Not Likely, 3 = Neutral, 4 = Likely, and 5 = Very Likely

Impacts	Very unlikely	Not Likely	Neutral	Likely	Very likely
The loss of one (1) contractor	1	2	3	4	5
The loss of two (2) contractors	1	2	3	4	5
The loss of three (3) contractors	1	2	3	4	5

With the above scenario, decision makers can now see a more accurate projection of how a reduction in funding at the 5% level would impact the MCPC. This will ensure that all possible repercussions of any proposed funding reductions are understood and considered before any decisions take place. Additionally, by incorporating probability into the outcomes, as is seen in the example above, additional research that follows will now be able to calculate probability distributions from expert's impact statements and deliver mathematical likelihoods that will only further increase the accuracy of the data and risk analysis.

To further support this concept examples from additional MCPCs are provided in the form of theoretical statements they could provide for a 5% reductions:

b. G/ATOR Example (See Table 3)

A 5% reduction in funding could lead to the following:

(1) Impacts implementation of either the Engineering Change Orders (ECO) in FY22, the FY22 Prime Vendor Sustainment Engineering and Logistics Support by over 50%, or reduces capability procuring only 44 vice 45 G/ATOR systems.

(2) Will not allow for the cut-in of Pallet Communications Support Processor in the FY22 production line impacting Radar Emplacement/Displacement time. Reduces FY22 ECO implementation by 90%.

(3) Reducing FY22 Prime Vendor Sustainment Engineering and Logistics Support by over 50% eliminating a yearly major software release. Reduces capability procuring only 44 vice 45 G/ATOR systems.

Table 3. G/ATOR Likert Table

For each of the statements, circle the response that most closely approximates the likelihood of the event, where: 1 = Very Unlikely, 2 = Not Likely, 3 = Neutral, 4 = Likely, and 5 = Very Likely

Impacts	Very unlikely	Not Likely	Neu tral	Likely	Very likely
Reduces FY22 ECO implementation	1	2	3	4	5
Reducing FY22 Prime Vendor Sustainment Engineering	1	2	3	4	5
Reduces capability procuring only 44 vice 45 G/ATOR systems	1	2	3	4	5

c. FOS-MADIS Example (See Table 4)

- A 5% reduction in funds could lead to the following:

(1) Reduce the number of systems by as few as three (3) or as many as fifteen (15).

(2) A reduction of systems by (3) equates to 3 LAAD sections (1 Platoon).

(3) A reduction in the number of systems by 7 LAAD sections would impact FY24 by two systems and FY25 by five systems. These reductions will impact deploy to dwell ratios for MEU support and inhibit UDP deployment.

(4) Reducing the number of systems by fifteen, or 3 platoons would cause a two-year delay in the full operational capability of the program.

(5) Risk to Mission: MADIS FOC delayed by one year. Fleet unable to support deploy to dwell ratio of MEU and UDP. Risk to Force: FMF units not defended from attack by manned/unmanned aircraft and missiles.

Table 4. FOS – MADIS Likert Table

For each of the statements, circle the response that most closely approximates the likelihood of the event, where: 1 = Very Unlikely, 2 = Not Likely, 3 = Neutral, 4 = Likely, and 5 = Very Likely

Impacts	Very unlikely	Not Likely	Neutral	Likely	Very likely
Reduction of Systems by three (3)	1	2	3	4	5
Reduction of Systems by Seven (7)	1	2	3	4	5
Reduction of Systems by fifteen (15)	1	2	3	4	5

Again seen above in Table 4, is a more accurate picture of a wider range of possible outcomes for a funding reduction. This example for the FOS-MADIS system only focuses on reducing the number of systems vice possibly incorporating cuts to one of the other five decision packages over the five year projection. A more spread out option over different packages may prevent this worst case scenario and provide more capability to the Marine Corps should budget cuts be required in that MCPC.

d. Staff and Operations Support HQMC Example (See Table 5)

A 5% reduction in funding could lead to the following:

(1) Completely eliminate the profile and any chance of effective planning capabilities, timely meeting must fund requirements constraining ability to fulfilling obligations.

(2) Possible reduction in 40081 C4, HQMC (Traveling/Training), or 670898 PP&O over the FYDP.

Table 5. Staff and Operations Support HQMC Likert Table

For each of the statements, circle the response that most closely approximates the likelihood of the event, where: 1 = Very Unlikely, 2 = Not Likely, 3 = Neutral, 4 = Likely, and 5 = Very Likely

Impacts	Very unlikely	Not Likely	Neutral	Likely	Very likely
Reduction in funding 40081 C4	1	2	3	4	5
Reduction in funding HQMC (Traveling/Training)	1	2	3	4	5
Reduction in funding 670898 PP&O	1	2	3	4	5

The examples in the Staff and Operations Support HQMC, seen above in Table 5, were created to demonstrate what it might look like and were not pulled from the prior year's MCPRIME inputs.

e. Semper Fit and Recreation Example (See Table 6)

A 5% reduction in funding levels could lead to the following:

(1) Eliminate funding for Outdoor and Recreation Programs. Most installations will be forced to reduce services or close operations.

(2) The Semper Fit Parks, picnics and playground program would be eliminated to include 32 FTEs. Installations would lose all funding for the maintenance of beaches, pavilions, trails and outdoor recreation areas. This would reduce services for recreational swimming for Marines and families at open water sites, creating an increased risk at those open water sites.

(3) Community Centers and associated programming will be eliminated. All Command and Community Special Events will be eliminated which would impact the relationship between military facilities and the surrounding civilian communities.

Table 6. Semper Fit and Recreations Likert Table

For each of the statements, circle the response that most closely approximates the likelihood of the event, where: 1 = Very Unlikely, 2 = Not Likely, 3 = Neutral, 4 = Likely, and 5 = Very Likely

Impacts	Very unlikely	Not Likely	Neutral	Likely	Very likely
Eliminate funding for Outdoor and Recreation Programs	1	2	3	4	5
The Semper Fit Parks, picnics and playground program would be eliminated	1	2	3	4	5
Community Centers and associated programming will be eliminated	1	2	3	4	5

Once they provide their estimates for the most likely and least likely impacts a more informed decision can be made regarding funding allocations. Opening up the range of impacts will enable Marine Corps decision makers an increased likelihood of making the right choices when funding reductions are required. Doing so also ensures the correct programs are being funded and the ability to meet mission requirements is maintained while continued support of the Commandant's key initiatives is at the forefront of any decisions made.

This first recommended approach is probably the easier one to execute as it only requires minimal changes to the questions and instructions currently in the MCPRIME system for MCPC managers to complete. Additionally, the addition of the Likert scale table should be a simple bit of coding that will enable the impacts to autofill from previous sections and clickable bubbles for the 1-5 scale responses in the probability portion. While the changes might seem simple the increase in value for the overall assessment of risk with the addition of the probability statements will advance the Marine Corps' ability to assess risk associated with difficult funding decisions.

3. Approach II: Parameter Estimate Method

The next approach devised for this paper will require much different tactics in how questions are presented and how funding level cuts and impacts are determined. The idea is that instead of presenting managers with a set 2%, 5%, and 10% funding reduction and then asking for impacts at those arbitrarily determined levels, instead open the dialog by asking, "given a funding cut what are three impacts that might happen to the programs in the order they would occur and what funding reduction would instigate these impacts?". By approaching it in this manner experts can now provide several expected impacts to their programs and more accurately deliver a precise funding reduction percentage that would commence said impacts. Now instead of only having locked in estimates at the three previous levels of cuts we will have estimates for impacts at levels that directly affect their programs in order of increasing severity. Once the impacts and estimated funding cut are provided the experts can then tie the impacts to one of their decision packages so decision makers know which part of the program is directly affected. Following this they will answer several probability questions that will describe what level of cuts they could receive without suffering impacts, what level of cuts might require impacts, and what level of cuts are certain to cause impacts. This method, known as the parameter estimate method, will introduce probability into the analysis both improving the immediate estimates and enabling additional calculations on probability distributions to occur. The last step in this approach will tie the impacts to a measure of effectiveness (MOE) or measure of performance (MOP) that the MCPC managers will be listing in MCPRIME 2.0 this next year. While data is not available at the moment for these measures, the following examples will demonstrate what it would look like if included.

a. Effects of Funding Reductions—Revision

The first step in this new process is reworking the effects of funding reductions section in the MCPRIME system to reflect what was described above. The new sections would look like the following:

(1) Instructions: Given a funding cut, what are three impacts that might happen to your program in the order they would occur and what funding reduction level would prompt these impacts?".

(2) Risk Analysis

1. Enter the specific Decision Package associated with each impact statement.
2. Enter the priority number associated with each impact statement. (If not lowest priority, provide justification explaining why higher priority would be impact first.)
3. Provide a detailed description of the impact your program would experience.
4. What funding cut could you sustain without having to suffer stated impacts?
5. What funding cut would it be unlikely for this impact to occur?
6. What funding cut would it be probable for this impact to occur?
7. What funding cut would it be certain for this impact to occur?
8. What MOE/MOP is most affected by the stated impacts?
9. On a scale of 1 to 5, how significant is this impact on the stated MOE/MOP with 1 being little to no impact and 5 being significant impact?

The remaining sections, internal risk assessment, risk to mission, and risk to force can be included unchanged from the previous version.

4. Examples of Approach II

The following section will include theoretical examples of this recommended approach based on data retrieved from the MCPCs in MCPRIME 1.0 this last year. The tabular display is used as a visualization tool in order to mimic the MCPRIME system text boxes and drop downs and is not a hard requirement for the future system.

(1) Staff and Operations Support HQMC

The Staff and Operations Support HQMC example was all theoretical as previous inputs had minimal details provided for impacts. (See Table 7.)

(2) Semper Fit and Recreation

In the Semper Fit and Recreation example there was a lot of detail provided in their previous MCPRIME inputs to use helping to visualize this proposed method. The priorities

were theoretical as they had labeled all of their decision packages priority 1, which is another issue that complicates this process. Overall this is one of the more detailed examples of what the basic table or fillable text boxes would look like and provide to the risk analysis process. (See Table 8.)

(3) Joint Fires Observer

In the JFO example there were only two provided decision packages, JFO CIV-N and JFO CIV-Y, that were both priority 1 and as such no further justification for the top priority being first impacted would be required. The details provided did a god job at escalating impacts with increased reductions and likelihoods of impacts. Their use of ranges in the second impact also help to induce a higher degree of realism as there is a high likelihood that impacts to funding reductions would occur in this manner vice the fixed, one proposed impact examples. (See Table 9.)

Table 7. Staff and Operations Support HQMC Approach II Table

Decision Package	Priority	Impact Statement	Sustainable	Unlikely	Probable	Certain	MOE MOP	Impact Significance
PP&O	1	Decreased ability to travel in support of mission requirements	1.5%	1.6%	1.75%	1.9%	MOE #1	4
M&RA O&M	1	Decreased TAD/Travel Funding	1.8%	1.9%	1.95%	2.1%	MOP #1	3
I&L	1	Expecting 40% decrease in capability to support operations	1.95%	2.0%	2.2%	2.5%	MOP #2	4

Table 8. Semper Fit and Recreation Approach II Table

Decision Package	Priority	Impact Statement	Sustainable	Unlikely	Probable	Certain	MOE MOP	Impact Significance
Fitness and Health Programs	7	This reduction would eliminate funding for Outdoor and Recreation Programs. Most installations will be forced to reduce services or close operations.	1.5%	1.6%	1.75%	1.9%	MOE #1	3
Recreation, Unit, and Deployment	6	The Semper Fit Parks, picnics and playground program would be eliminated to include 32 FTEs. Installations would lose all funding for the maintenance of beaches, pavilions, trails and outdoor recreation areas.	1.8%	1.9%	1.95%	2.0%	MOP #2	4
Aquatics Program (CIV-N)	5	Installations will no longer be able to offer Cat B aquatics programs which included guarded open water areas and recreational swimming at installation pools which would negatively impact Marines and their families. There will be increased risk at open water sites.	1.9%	1.95%	2.0%	2.1%	MOE #2	4

Table 9. Joint Fires Observer Approach II Table

Decision Package	Priority	Impact Statement	Sustainable	Unlikely	Probable	Certain	MOE MOP	Impact Significance
JFO	1	Result in the loss of one (1) contracted instructor from the total contractor instructor cadre of twenty (20), spread across three formal schools. The loss of one (1) contractor reduces the capacity in the aggregate by approximately two (2) JFO classes and associated student throughput by 10% or approximately 38 students.	1.5%	1.6%	1.75%	2.0%	MOP #1	3
JFO	1	Result in the loss of two (2) contracted instructors from the total contractor instructor cadre of twenty (20), spread across three formal schools. The loss of two (2) contractors reduces the capacity in the aggregate by approximately three (3) JFO classes and associated student throughput by 15% or approximately 58 students.	1.8%	1.9%	2.0%	2.2%	MOP #1	4
JFO	1	Result in the loss of three contracted instructors from the total contractor instructor cadre of twenty (20), spread across three formal schools. The loss of 3 contractors reduces the capacity in the aggregate by approximately four (4) JFO classes and associated student throughput by 20% or approximately 76 students.	1.9%	2.1%	2.5%	3.0%	MOE #1	5

(4) FOS-MADIS

In the FOS-MADIS example the first impacted decision package is the number one priority which would require justification. It could be as simple as “this decision package has 95% of the budget and therefore can sustain the cut better than the other decision packages” or that the “other packages are all supporting this one and cutting any one of the others would result in the whole program failing.” Similar to the JFO example again we see escalating impacts going from 3 to 7 and then 15 systems affected which provides a nice consistency to the estimate. Lastly the MOP impacted here is forecasted to be the same for each impact as the decision package is the same and the likely MOP associated with it would also likely repeat. The impact severity on the MOP was escalated as the number of systems reduced increased. (See Table 10.)

(5) G/ATOR

The G/ATOR MCPC has only two decision packages which again has the top priority impacted first and could be explained in any of the aforementioned methods above. The impacts to the program in this example affect different areas of the development of the system and its capabilities and would likely affect different MOPs or MOEs as shown above. In an actual MCPRIME system the MOE/MOP section would likely be a more detail text box providing MCPC managers an opportunity to fully detail and explain how impacts would degrade their MOE/MOP. (See Table 11.)

Table 10. FOS – MADIS Approach II Table

Decision Package	Priority	Impact Statement	Sustainable	Unlikely	Probable	Certain	MOE MOP	Impact Significance
MADIS Increment I Programmed	1	The first impact would be a reduction to the number of systems by (3) which equates to 3 LAAD sections (1 Platoon). This will impact deploy to dwell ratios for MEU support and inhibit UDP deployment. Risk to Mission: MADIS FOC delayed by one year. Fleet unable to support deploy to dwell ratio of MEU and UDP. Risk to Force: FMF units not defended from attack by manned/unmanned aircraft and missiles.	1.5%	1.6%	1.75%	2.0%	MOP #1	3
MADIS Increment I Programmed	1	A 5% reduction in funds reduces the number of systems by 7 LAAD Sections. This will impact deploy to dwell ratios for MEU support and inhibit UDP deployment. Risk to Mission: FOC of LAAD modernization / fielding of FMF Counter-UAS capabilities delayed by one year. Risk to Force: FMF units not defended from attack by manned/unmanned aircraft and missiles.	1.8%	1.9%	2.0%	2.2%	MOP #1	4
MADIS Increment I Programmed	1	A 10% reduction of funds reduces the number of systems by 15 LAAD Sections (3 Platoons) Risk to Mission: FOC of LAAD modernization / fielding of FMF Counter-UAS capabilities delayed by two years. Risk to Force: FMF units not defended from attack by manned/unmanned aircraft and missiles.	1.9%	2.1%	2.2%	2.3%	MOP #1	5

Table 11. G/ATOR Approach II Table

Decision Package	Priority	Impact Statement	Sustainable	Unlikely	Probable	Certain	MOE MOP	Impact Significance
G/ATOR Program of Record	1	First impact affects implementation of Engineering Change Orders (ECO) in FY22 and will not allow for the cut-in of Pallet Communications Support Processor in the FY22 production line impacting Radar Emplacement/Displacement time.	1.5%	1.6%	1.75%	2.0%	MOP #1	3
G/ATOR Program of Record	1	The second impact reduces FY22 Prime Vendor Sustainment Engineering and Logistics Support by over 50% eliminating a yearly major software release.	1.8%	1.9%	2.0%	2.2%	MOP #2	4
G/ATOR Program of Record	1	The third impact expected would be to reduce capability by procuring only 44 vice 45 G/ATOR systems. Impacts future IROAN capability with one less system and the ability to stand-up a complete IROAN capability . FOC will not be achieved without a future payback with potentially a significant increase in unit cost.	1.9%	2.1%	2.2%	2.3%	MOE #1	4

All of these examples were used to simply visualize this recommended approach and could be modified and/or adjusted as needed to fit into the new MCPRIME system. When complete, the inclusion of this approach would provide a much more accurate risk analysis than previous methods and make resource and funding decisions far more effective. Additionally, one last step to this process would be fitting a distribution to the expert's statements. Garthwaite discussed this in his 2005 saying,

> Once the facilitator has obtained from the expert a number of specific statements, the elicitation task is completed by converting these into a probability distribution. Different levels of complexity are found in the fitting of a probability distribution to the expert's statements. The simplest form of elicitation is to ask the expert to specify a range [a,b] in which the parameter is believed to lie. (p. 688)

This method of creating a distribution from expert inputs is demonstrated in appendix F of this paper and will use the FOS-MADIS data as inputs. While methods may vary depending on whether data is continuous or discrete the concepts behind how to build this distribution will lay the foundation for data scientist to carry out the task.

The final chapter of this paper will look at the research that has been conducted, draw conclusions from what was discovered, and then make recommendations for future improvements as well as future research to be conducted on this topic.

V. CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

In his 2019 Commandant's Planning Guidance, General Berger emphasized,

> The coming decade will be characterized by conflict, crisis, and rapid change – just as every decade preceding it. And despite our best efforts, history demonstrates that we will fail to accurately predict every conflict; will be surprised by an unforeseen crisis; and may be late to fully grasp the implications of rapid change around us. The Arab Spring, West African Ebola Outbreak, Scarborough Shoal standoff, Russian invasion of eastern Ukraine, and weaponization of social media are but a few recent examples illustrating the point. While we must accept an environment characterized by uncertainty, we cannot ignore strong signals of change nor be complacent when it comes to designing and preparing the force for the future. (p. 1)

The key points he makes here are the need for adaptation to changing requirements and being cognizant of strong signals of change. An in-depth and thorough ERM methodology for the Marine Corps would be a giant leap towards meeting these objectives and better enable the United States to meet new and uncertain threats. The ability to recognize risks and impacts that arise when budgets need to be adjusted as well as the improved speed with which those decisions on funding could be made are just what the Marines need in order to shift focus rapidly when new threats appear and mission set change. It is not simply a process of reporting potential issues or impacts, but more so a process of providing intimate insight into programs while also giving decision makers enhance flexibility and control over which initiatives to support and which ones to divest in. This idea is also mentioned by General Berger in that 2019 message when he stated, "We must communicate with precision and consistency, based on a common focus and a unified message" (para. 4). Creating a system that supports this ideology and clears of the lines of communication from MCPC managers to decision makers is one of the goals of the ERM approach one objective of this research.

The objective of this study was to review current Marine Corps risk management processes and methodologies to identify best practices that could be incorporated into the planned ERM implementation where time or cost are reduced, estimates improved, and

outcomes made more impactful. To achieve these objectives this research conducted an analysis of the current methods and procedures, recommended process improvements, and identified ways to determine what the risks are associated with funding decisions and how they can be used in the future ERM process.

This research took an in-depth deep dive into the MCPRIME system used to identify risks and impacts and evaluated five different MCPCs from four separate PEBs in order to review a diverse array of inputs, discover issues and areas for improvement, and then develop new methods and techniques that will ultimately lead to a solid ERM process for the Marine Corps.

B. MCPRIME ANALYSIS

During this research, a thorough review of MCPRIME system inputs and risk statements revealed a solid foundational framework that with some technical enhancements will provide the Marine Corps with an inherent understanding of risks and concerns accompanying funding and resource adjustments. Some of the concerns with the previous iteration of MCPRIME as detailed in chapter 4.A.3 were the following:

- Priorities for decision packages were not completed as per instructions and failed to provide insight as to what packages took precedence over others.
- Many of the decision package mission statements were incomplete and/or skipped altogether making it difficult to tie the packages to mission requirements and the Commandant's Guidance
- Impact statements provided for varying funding reductions were immediately tied to the programs highest priority decision package without due justification or explanation. (Generally, a 2% cut would be applied to low priority discretionary measures vice essential program elements.)

- There was a general lack of information in MCPRIME regarding MOE/MOPs for programs as well as a lack of clarity on how those would tie to higher level objectives or mission.

- Funding reductions in the previous iteration were set at arbitrary levels and only required one risk impact for each level making MCPC managers focus on only what that funding cut would impact at that specified level.

- Many of the impact statements over a couple of different MCPCs had cut and pasted impact statements over the varying cut levels and provided little if any insight as to what those cuts would impact.

- There was no inclusion of any sort of probability measure in the MCPRIME risk analysis system making it very difficult to identify the likelihood of risks actually occurring.

Overall, many of the issues stated could be attributed to human error during the completion of inputs while some of the concerns dealt directly with the system itself and areas that could be improved. For detailed breakdown of above issues, see Table 1. Some of the strengths the system possessed that can be incorporated into future iterations are:

- The inclusion of the priority ranking system, when completed appropriately provides a more thorough understanding as to what elements of the programs one would expect funding cuts to impact.

- The mission description section can help link the programs mission to higher headquarters' initiatives and Marine Corps objectives. The inclusion of the MOE/MOP in future iterations will also help to drastically enhance the awareness of decision makers.

- The risk analysis section was a good start and provided detailed impacts (when completed correctly), links to priorities, and severity of impacts. All of these are essential in understanding hos risks will affect programs.

- Finally, the requirement to provide multiple impact statements for various set funding cuts was a helpful tool, but can be improved if levels aren't arbitrarily set.

Altogether, the MCPRIME system is a good start and with the incorporation of some of the recommendations in the following section will be much closer to providing an ERM process for the Marine Corps.

C. RECOMMENDATIONS

A key component in the development of an ERM for the Marine Corps is the ability to draw out detailed assessments of risk impacts and the probabilities of those impacts and then have that system tie the program's mission to that of the Marine Corps while also forecasting impacts to MOEs/MOPs. Once risks are provided and mission essential tasks are understood, impacts need to be linked to program priorities and justified for any that bypass lower priorities for higher. This step is useful in ensuring honest and accurate responses in the impact statements and should help to alleviate known biases that naturally exist due to the experts close relationships to the programs. Once priorities have been identified and justified MCPC managers can then provide a series of responses to probabilities statements that will enable the MCPRIME facilitators to draw out likelihoods and then create a probability distribution from the data. This step will be demonstrated in appendix F for the FOS-MADIS data provided in approach II. The next step will be the inclusion of the MOE/MOP that is affected by the impacts forecasted and a severity rating stating what degree of degradation is expected in that MOE/MOP.

Once the MCPRIME system has been updated with new risk analysis input requirements and run through a full year of submissions the data will need to be calibrated the following year. This could be done by requiring a simple follow-up section the next year that MCPC managers complete that could receive information on what funding reductions they actually received that year as well as actual impacts to the program that were experienced. By going through this calibration step, future data can be processed and distributions run to estimate just how accurate impact statements and funding reduction estimates were which will then provide an adjustment measure for future iterations to

improve those statements. All of these recommendations align with what was demonstrated during approach II in chapter 4. Approach I was created to make minor adjustments and alterations to MCPRIME 1.0 but as a newer version of MCPRIME is preparing for release with updated requirements, approach I would now be less efficient.

D. LIMITATIONS

The limitations experienced during the conduct of this research include the limited ability to test only a small sample of the data. The MCPRIME system consists of hundreds of MCPC inputs and would have been impractical to test. The sample of five MCPCs that were tested were drawn from four different PEBs in order to get a diverse range of data for analysis. Other limitations included a lack of historical data for years past from MCPCs that could have been used to see trends in risk estimates and create more detailed probability distributions measuring the accuracy of forecasted cuts and impacts. Finally, due to COVID-19 guidelines, the researchers were restricted from traveling to HQMC and the Pentagon in order to meet with sponsors and MCPC managers which could have provided more detailed data and analysis of methods currently being conducted. Due to that inability, regular online meetings and conference calls had to suffice but were more limited in scope and depth than in person interviews and meetings would likely have been.

E. FUTURE RESEARCH

Continuing where this research ends, future researchers can begin developing tools for determining how to attack the multi-criteria decision making problem that lies with risk management. Calculating how the risks to diverse program objectives weigh against one another when provided by MCPCs in the MCPRIME system and how adjusting budgets for any one program will affect that program's overall capability. while keeping the Marine Corps' goals and objectives at the forefront. Future research should also provide future opportunities to work on the techniques that will be required to follow-up on MCPRIME inputs from year-to-year and detail what a calibration tool might look like that will enable increased accuracy in future risk estimates. Finally, more research could be conducted to improve the methods used to acquire risk data either in the MCPRIME system as USMC gains experience in formal specifications of risk and uncertainty. Determining the need for

professional facilitation in order to train users on how to appropriately complete their MCPRIME inputs is also an area of interest that could provide for future research.

APPENDIX

A. FAMILY OF SYSTEMS – MARINE AIR DEFENSE INTEGRATED SYSTEM MCPRIME SYSTEM INPUTS

1. Decision Packages

On page three of this document are the "Decision Packages" inputs. This allows for breaking down MCPC into its component capabilities and natural spending bins which allows everyone to more clearly understand where money is spent within a MCPC. These packages provide a detailed overview of what funding is for different elements of their MCPC as well as a recommendation and description for what the Marine Corps should do if it is underfunded. The packages that should be mentioned as they relate to this paper are:

a. ***MADIS Increment I Right Sizing.*** *This initiative is required due to schedule and procurement changes allowing for integration, engineering, developmental, and operational testing in order to reach milestone C. It also allows for technological advancements to counter the evolving air threat. If under-funded MADIS Increment 1 systems will not include a high powered microwave capability nor an SVUL capability, mitigating full spectrum air defense threats. These capabilities provide increased lethality protecting the Warfighter against evolving hostile aerial threats. The risk is assumed by 2d/3d LAAD Bn who will not achieve full AAO leaving legacy systems with reduced capabilities in the Fleet. Priority 2. Provides 15% capability to the program.*

b. ***I-MADIS New Initiative.*** *Provides increased C-sUAS capacity to defend critical assets aboard installations CONUS and OCONUS. Increases fielding quantities from 1 to 2 systems per year. If under-funded I-MADIS fielding to installations will not be completed for decades. Many installations will not receive a C-sUAS capability within a reasonable timeframe. Risk is assumed by the Installation Commanders. Priority 6. Provides 5% capability to the program.*

c. ***L-MADIS.*** *Provides MEUs with a roll-on, roll off C-UAS capability to defend while at sea and ashore. If under-funded L-MADIS will not transition to a PoR and current L-MADIS will sundown 3QFY22. The MEUs will not have a roll-on, roll-off C-UAS capability and risk will be*

assumed by the MEU Commanders. Priority 5. Provides 5% capability to the program.

d. ***1st Low Altitude Air Defense Battalion Reactivation.*** *Provides a permanent short range air defense capability to equip and train III MEF Forces. Failure to reactivate, staff, equip, and train 1st LAAD will leave III MEF to assume the risk with being unable to organically conduct air defense operations. Priority 3. Provides 10% capability to the program.*

e. ***MADIS Increment 1 Programmed.*** *Provides the Marine Corps with an organic, upgradeable, and state of the art Air Defense capability to protect Fleet Marine Forces from aerial threats. Priority 1. Provides 60% capability to the program. No funding delta statement.*

f. ***I-MADIS Programmed.*** *Provides a C-sUAS capability to defend critical assets aboard installations CONUS and OCONUS. Priority 4. Provides 5% capability to the program. No funding delta statement.*

2. Effects of Funding Reductions

This section requires subject matter experts (SME) to provide their opinions regarding any negative impacts they foresee if funding is reduced by 2%, 5%, or 10%. SMEs are reminded to provide separate word pictures for each cut and not to write the same assessment for each percentage. They are also asked to look at the risk assessment from a program perspective and try to minimize subjectivity as much as possible. Impacts are then rated on the following scales:

a. ***Risk to Mission:*** *Ability to execute assigned missions at acceptable human, materiel, financial, and strategic cost.*

- Minor (1-3): Very likely (80-100%) achievement of objectives for future operations and contingencies.
- Moderate (4-5): Likely (50-80%) achievement of objectives for future operations and contingencies.
- Major (6-7): Questionable (20-50%) achievement of objectives for future operations and contingencies.

- Extreme (8-9): Unlikely (0-20%) achievement of objectives for future operations and contingencies.

b. ***<u>Risk to Force</u>:*** *Ability to recruit, man, train, equip, and sustain the force to meet strategic objectives.*

- Minor (1-3): Risks are completely mitigated by existing USMC capabilities; no loss to personnel / equipment.
- Moderate (4-5): Risks are partially mitigated by existing USMC capabilities; minimal loss to personnel / equipment.
- Major (6-7): Risks are partially mitigated by existing USMC capabilities; significant loss to personnel / equipment.
- Extreme (8-9): Risks cannot be mitigated by existing USMC capabilities; grave loss to personnel / equipment.

c. ***Risk Analysis:***

- Enter the specific Decision Package that the reduction impacts
- Describe the exact impact to your MCPC
- Quantify the impact severity from 1 (low) to 9 (high)

2% Reduction Effects. A 2% reduction reduces the number of systems by (3) which equates to 3 LAAD sections (1 Platoon). This will impact deploy to dwell ratios for MEU support and inhibit UDP deployment. Risk to Mission: MADIS FOC delayed by one year. Fleet unable to support deploy to dwell ratio of MEU and UDP. Risk to Force: FMF units not defended from attack by manned/unmanned aircraft and missiles.

5% Reduction Effects. A 5% reduction in funds reduces the number of systems by 7 LAAD Sections. This will impact deploy to dwell ratios for MEU support and inhibit UDP deployment. Risk to Mission: FOC of LAAD modernization / fielding of FMF Counter-UAS capabilities delayed by one year. Risk to Force: FMF units not defended from attack by manned/unmanned aircraft and missiles.

10% Reduction Effects. A 10% reduction of funds reduces the number of systems by 15 LAAD Sections (3 Platoons) Risk to Mission: FOC of LAAD modernization / fielding of FMF Counter-UAS capabilities delayed by two years. Risk to Force: FMF units not defended from attack by manned/unmanned aircraft and missiles.

B. STAFF OPERATIONS AND SUPPORT – HQMC MCPRIME SYSTEM INPUTS

1. Decision Packages

The detailed description of the inputs for this section can be reference in the section A above.

a. ***40027 HQMC (Travel/Training).*** *No description provided. Priority 1. Provides 0% capability to the program. Recommended full funding. SME recommendation would be to move all the funding to M40085 which is a HQMC WCI that executes funding. No funding delta statement provided.*

b. ***40080 Administration and Resource.*** *No description provided. Priority 1. Provides 10% capability to the program. Misaligned CIV-Y funding is to be realigned to M00092 Labor for AR-Division CIV-Y.*

c. ***40081 C4.*** *No description provided. Priority 1. Provides 4% capability to the program. Recommended full funding. No funding delta statement provided.*

d. ***40084 M&RA O&M (CMC Discretionary).*** *No description provided. Priority 1. Provides 6% capability to the program. Recommended full funding. No funding delta statement provided.*

e. ***40084 M&RA O&M (Non-Discretionary).*** *No description provided. Priority 1. Provides 10% capability to the program. Recommended full funding. No funding delta statement provided.*

f. ***40085 Resources Finance and Operation.*** *No description provided. Priority 1. Provides 3% capability to the program. Recommended full funding. No funding delta statement provided.*

g. ***40086 Administrative Support DMCS.*** *No description provided. Priority 1. Provides 1% capability to the program. Recommended full funding.*

Misaligned MIP funds to be realigned to the appropriate Intel Staff Support account.

h. ***670898 PP&O.*** *No description provided. Priority 1. Provides 0% capability to the program. Recommended full funding. No funding delta statement provided.*

i. ***40490 I&L.*** *No description provided. Priority 1. Provides 0% capability to the program. Recommended full funding. No funding delta statement provided.*

j. ***670898 MCCDC.*** *No description provided. Priority 1. Provides 0% capability to the program. Recommended full funding. No funding delta statement provided.*

k. ***40005 Marine Corps Base Quantico.*** *No description provided. Priority 1. Provides 0% capability to the program. Recommended full funding. No funding delta statement provided.*

l. ***40494 MCICOM.*** *No description provided. Priority 1. Provides 0% capability to the program. Recommended full funding. No funding delta statement provided.*

m. ***40681 MARCORPS Base Camp Pendleton.*** *No description provided. Priority 1. Provides 0% capability to the program. Recommended full funding. No funding delta statement provided.*

n. ***47001 MARCORPS Lejeune.*** *No description provided. Priority 1. Provides 0% capability to the program. Recommended full funding. No funding delta statement provided.*

o. ***47400 MARCORPS Camp Butler.*** *No description provided. Priority 1. Provides 0% capability to the program. Recommended full funding. No funding delta statement provided.*

p. ***40027 HQMC OMMCR.*** *No description provided. Priority 1. Provides 0% capability to the program. Recommended full funding. No funding delta statement provided.*

q. ***40084 M&RA OMMCR.*** *No description provided. Priority 1. Provides 0% capability to the program. Recommended full funding. No funding delta statement provided.*

r. ***40085 HQMC Resources Finance and Operation OMMCR.*** *No description provided. Priority 1. Provides 0% capability to the program. Recommended full funding. No funding delta statement provided.*

s. ***47861 MARFORRES OMMCR.*** *No description provided. Priority 1. Provides 0% capability to the program. Recommended full funding. No funding delta statement provided.*

t. ***HQMC LABOR (CIV Y).*** *No description provided. Priority 1. Provides 66% capability to the program. Recommended full funding. No funding delta statement provided.*

2. Effects of Funding Reductions

2% Funding Reduction. Staff Ops & Support programs that have funding deficiencies are DMCS Staff Agencies (to include G10, EOS & GOS), DoN Tracker, Mass Transit, Inspector General, Travel Missions (Aviation and the Commandant), Information Technology, Operations and Fiscal Management, Logistics and Publishing, Records Management, HROM/EEO, SJA, Security Programs, and the PA&E Analytical Contract which ends in FY22. Severity 7 (Major).

5% Funding Reduction. Staff Ops & Support programs that have funding deficiencies are DMCS Staff Agencies (to include G10, EOS & GOS), DoN Tracker, Mass Transit, Inspector General, Travel Missions (Aviation and the Commandant), Information Technology, Operations and Fiscal Management, Logistics and Publishing, Records Management, HROM/EEO, SJA, Security Programs, and the PA&E Analytical Contract which ends in FY22. Severity 8 (Extreme).

10% Funding Reduction. Staff Ops & Support programs that have funding deficiencies are DMCS Staff Agencies (to include G10, EOS & GOS), DoN Tracker, Mass Transit, Inspector General, Travel Missions (Aviation and the Commandant), Information Technology, Operations and Fiscal Management, Logistics and Publishing, Records Management, HROM/EEO, SJA, Security Programs, and the PA&E Analytical Contract which ends in FY22. Severity 9 (Extreme).

This MCPC provides the same word picture for all levels of reductions while increasing the severity and failing to explain why the impacts are more severe.

C. SEMPER FIT AND RECREATION MCPRIME SYSTEM INPUTS

1. Decision Packages

a. ***Validated Core Labor Funding (CIV-N).*** *If under-funded facilities such as fitness centers and recreation centers may not meet the manning requirements for safety and basic operating functions as required by DODI 1015.10. This will impact the availability of key fitness equipment and programming which may negatively affect combat readiness. Priority 1. Provides 0% capability to the program.*

b. ***Materials and Supplies (Including Equipment) (CIV-N).*** *If under-funded equipment is degraded and will become unserviceable posing safety issues and failing to meet the mandate of providing Marines the means necessary to meet their fitness training requirements. Semper Fit programs will be forced to reduce services as basic operating costs are not covered which may negatively affect combat readiness. Priority 1. Provides 0% capability to the program.*

c. ***Validated Human Performance Staffing (CIV-N).*** *If under-funded Semper Fit will not provide the most effective and efficient support to Marines across the areas of human performance, tactical strength and conditioning, injury prevention, return to duty programs, performance nutrition, military aquatics, and recreational activities that support constructive behaviors. Priority 1. Provides 0% capability to the program.*

d. ***Fitness and Health Programs (CIV-N).*** *No description provided. Priority 1. Provides 35% capability to the program. Recommended full funding. No funding delta statement provided.*

e. ***Fitness and Health Programs (CIV-Y).*** *No description provided. Priority 1. Provides 5% capability to the program. Recommended full funding. No funding delta statement provided.*

f. ***Sports and Athletics Programs (CIV-N).*** *No description provided. Priority 1. Provides 10% capability to the program. Recommended full funding. No funding delta statement provided.*

g. ***Sports and Athletics Programs (CIV-Y).*** *No description provided. Priority 1. Provides 2% capability to the program. Recommended full funding. No funding delta statement provided.*

h. ***Aquatic Programs (CIV-N).*** *No description provided. Priority 4. Provides 12% capability to the program. Recommended full funding. No funding delta statement provided.*

i. ***Aquatic Programs (CIV-Y).*** *No description provided. Priority 4. Provides 1% capability to the program. Recommended full funding. No funding delta statement provided.*

j. ***Recreation, Unit, and Deployment Support (CIV-N).*** *No description provided. Priority 4. Provides 14% capability to the program. Recommended full funding. No funding delta statement provided.*

k. ***Recreation, Unit, and Deployment Support (CIV-Y).*** *No description provided. Priority 4. Provides 1% capability to the program. Recommended full funding. No funding delta statement provided.*

l. ***Single Marine Program (CIV-N).*** *No description provided. Priority 1. Provides 4% capability to the program. Recommended full funding. No funding delta statement provided.*

m. ***Single Marine Program (CIV-Y).*** *No description provided. Priority 1. Provides 2% capability to the program. Recommended full funding. No funding delta statement provided.*

n. ***Outdoor Recreation Programs (CIV-N).*** *No description provided. Priority 2. Provides 2% capability to the program. Recommended full funding. No funding delta statement provided.*

o. ***Outdoor Recreation Programs (CIV-Y).*** *No description provided. Priority 2. Provides 1% capability to the program. Recommended full funding. No funding delta statement provided.*

p. ***Community Centers and Programs (CIV-N).*** *No description provided. Priority 3. Provides 1% capability to the program. Recommended full funding. No funding delta statement provided.*

q. ***Community Centers and Programs (CIV-Y).*** *No description provided. Priority 3. Provides 1% capability to the program. Recommended full funding. No funding delta statement provided.*

r. ***Semper Fit Management (CIV-N).*** *No description provided. Priority 3. Provides 7% capability to the program. Recommended full funding. No funding delta statement provided.*

s. ***Semper Fit Management (CIV-Y).*** *No description provided. Priority 3. Provides 2% capability to the program. Recommended full funding. No funding delta statement provided.*

2. Effects of Funding Reductions

2% Funding Reduction. The entire health promotion program would be eliminated which is our primary prevention mechanism across the previously mentioned key areas. In FY19, there were 9,992 classes and briefs for 44,986 Marines and family members; 763 customer outreach activities; 5,372 one-on-one consults with Marines and family members; 16,334 collaborative activities for 148,621 Marines and family members. This reduction would eliminate funding for Outdoor and Recreation Programs. Most installations will be forced to reduce services or close operations.

5% Funding Reduction. This reduction would eliminate funding for Outdoor and Recreation Programs. Most installations will be forced to reduce services or close operations. The Semper Fit Parks, picnics and playground program would be eliminated to include 32 FTEs. Installations would lose all funding for the maintenance of beaches, pavilions, trails and outdoor recreation areas. This would reduce services for recreational swimming for Marines and families at open water sites, creating an increased risk at those open water sites.

10% Funding Reduction. Installations will no longer be able to offer services provided by the Health Promotion Program, which will negatively impact Marines and their families in areas such as performance nutrition counseling, injury prevention, and tobacco cessation. Installations will no longer be able to offer Cat B aquatics programs which included guarded open water areas and recreational swimming at installation pools which would negatively impact Marines and their families. There will be increased risk at open water sites. Community Centers and associated programming will be eliminated. All Command and Community Special Events will be eliminated which would impact the relationship between military facilities and the surrounding civilian communities.

It is clear that this MCPC SME was very thorough in detailing the impacts to all affected programs and initiatives during their submission even going as far as to provide numbers of individuals the programs catered to in the prior year.

D. JOINT FIRES OBSERVER MCPRIME SYSTEM INPUTS

1. Decision Packages

a. ***Joint Fires Observer.*** *JFOs provide units the capability to assess joint fires across the ROMO. A JFO can request, adjust, & control surface-to-surface fires, provide targeting information in support of Type II and III close air support (CAS) terminal attack controls, and perform autonomous terminal guidance operations. JFO expands the capacity for Type I and II control of CAS to the platoon level. Priority 1. No funding delta statement provided. Provides 50% capability to the program.*

b. ***JFO CIV Y.*** *No description provided. Priority 1. Provides 50% capability to the program. Recommended full funding. No funding delta statement provided.*

2. Effects of Funding Reductions

2% Funding Reduction. A 2% reduction risk is manageable if executed at the two EWTGs from an instructor cadre standpoint. A 2% reduction at MRDET Ft. Sill would impact the required 2:1 Student/Instructor ratio (required during simulations); whereby, the 2% reduction equates to the loss of ~ one (1) instructor and a 25% decrement to the 4-man instructor cadre.

5% Funding Reduction. 5% reduction risk and loss of 2 instructors would be manageable, if occurring at the EWTGs. A 5% reduction at MARDET Ft. present a greater impact on maintaining the required 2:1 student/instructor ratio during course simulations; whereby the 5% reduction as well as representing a 50% decrement to the 4-man instructor cadre. The loss of two (2) contractors reduces the capacity in the aggregate by approximately three (3) JFO classes and associated student throughput by 15% or approximately 58 students.

10% Funding Reduction. 10% reduction will affect the program by reducing the instructor cadres at the EWTGs and MARDET Ft. Sill, with the latter site experiencing a ~75% reduction of the 4-man contractor instructor cadre if the entire 10% reduction was levied upon Ft. Sill. A recommended COA would be to levy the entire 10% reduction onto the contractor instructor cadre at MARDET Ft. Sill; thereby, prioritizing JFO seats to the FMF. Marine 0802 Artillery Officers undergo JFO training during the MAOBC (not part

of the POI) are qualified but not certified, which would occur in the FMF if assigned as a JFO.

E. GROUND/AIR TASK ORIENTED RADAR (G/ATOR) MCPRIME SYSTEM INPUTS

1. Decision Packages

a. ***Emplacement/Displacement ECO Implementation.*** *Software/hardware changes to meet GB2 CPD KSA, reduction in emplacement/ displacement provides for system and force survivability and the ability to maintain pace with the Force. These changes and their value will apply to all 45 G/ATOR systems. If under-funded this DP is PMC funding which provides required software/ hardware changes to meet the G/ATOR Block 2 CPD, KSA for emplacement/displacement times. Additionally it enhances both system and force survivability against the pacing threat and applies towards radar mobility to maintain pace with the force. Priority 2. Provides 0% capability to the program.*

b. ***GB2 User Improvements.*** *Required improvements to the user interface to enables the user to access the full spectrum of G/ATOR's capabilities. If under-funded this DP is RDT&E funding which provides required improvements to the user interface discovered during IOT&E that enable the user to utilize the full spectrum of the systems capability. Priority 3. Provides 0% capability to the program.*

c. ***NCTR.*** *Provides for the discrimination/classification of targets not providing a friendly ID. This DP is RDT&E funding which provides for the classification to the type/model, through the optimization of transmissions and receiver/ processing techniques for targets not providing any cooperative ID. This is an FY21 UPL Item ($5.0M) Priority 4. Provides 0% capability to the program.*

d. ***Ground/Air Task Oriented Radar Program of Record.*** *This is the Program of record to fulfill the current APB for Full rate production. Priority 1. No under-funded impact given as they request it be fully funded as essential to the entire program. Provides 98% capability to the program.*

e. ***Low, Slow, Small Target Detection.*** *Provides for the discrimination od targets below the current minimum velocity threshold (classified). Identified for situational awareness. Congress funded initial year of the primarily software development effort in support of the Counter-UAS mission. This is*

an FY21 UPL item ($5.0M). FY22/23 Funding tails were identified on the FY21 UPL paper. Priority 6. Provides 2% capability to the program.

f. ***Radar Signal Processor Refresh.*** *Technical Refresh of the Radar signal Processor (RSP) for 45 systems, current RSP is operating with 2007 vintage processors, refresh of the RSP allows for greater fidelity and throughput of targets required for engagement for MRIC and NIFC-FTS. By not funding this DP and procuring a full refresh of the RSP restricts further development and incorporation of future modes of operation due to limited processor capabilities. Priority 5. Provides 2% capability to the program.*

2. Effects of Funding Reductions

2% Funding Reduction. Risk is moderate, especially in FY22. However, not implementing the cut-in of PCSP in the production line in FY22 misses out on the opportunity to improve G/ATOR emplacement/displacement times at half the cost of having to perform the desired retrofit upgrade in the future. Emplacement/ displacement times (KSA G/ATOR Block2) are paramount as a system/force survivability and maintaining pace with the force.

5% Funding Reduction. Risk is moderate and includes the above 2% risk as well. At a minimum, G/ATOR plans for one minor and one major software release per year. Missing a major software release will negatively impact both system readiness and mission capability in FY22.

10% Funding Reduction. A 10% reduction will impact both the procurement of one system and the ability to stand-up a complete IROAN capability at the Depot. FOC will not be achieved without a future payback with potentially a significant increase in unit cost. Impacts Operational Availability of systems in the Fleet due to increased turnaround time to perform IRON of each system.

F. CREATING A PROBABILITY DISTRIBUTION (FOS – MADIS)

Following the elicitation of expert statements and impacts for funding reductions, analysis can be conducted on the data provided by creating a probability distribution from either discrete or continuous inputs. For the example that will be shown here a discrete set of data was used from the FOS-MADIS inputs provided in MCPRIME. From the three impact statements, it was identified that the programs would have to reduce Low Altitude Air Defense systems by 3, 7, or 15 for the given funding reduction which was held constant

at 2%, as is recommended in approach II. The x-axis contains the number of systems reduced while the y-axis is the probabilities, which for simplicity was given a continuous triangular distribution with parameters at 5% and 95 % for the low and high estimates.

x-axis	prob	
3	0.05	
7	0.5	
15	0.95	
min	a	0.64
max	b	18.12
Mode	c	7

Figure 3. Probability Distribution Inputs

Once the triangular distribution was created, statistics were run on the data and the minimum, maximum, and mode were revealed and are seen in Figure 3.Once this step was done the data needed to be discretized by calculating the cumulative distribution function for each of the values between the minimum and maximum using the formulas in Figure 4.

CDF

$$\begin{cases} 0 & \text{for } x \le a, \\ \frac{(x-a)^2}{(b-a)(c-a)} & \text{for } a < x \le c, \\ 1 - \frac{(b-x)^2}{(b-a)(b-c)} & \text{for } c < x < b, \\ 1 & \text{for } b \le x. \end{cases}$$

Figure 4. Triangular Distribution CDF Formulas

Cumulative probabilities are calculated starting from the min and then at each integer break-point, 1.5, 2.5, 3.5, etc. until the max. These calculation are seen in Figure 5. Once the CDF is calculated the values from 1 to 18 were placed in a new column and a discretized PDF was calculated by adding the value from the adjacent column in the CDF and subtracting the previous CDF probability value. Once all the calculations were done a final check was run via simulation in the last column to confirm the results were correctly calculated.

CDF		Discretized PDF		
0.64	0	Loss	Prob	Check
1.5	0.006653	1	0.006653	0.006653
2.5	0.031119	2	0.024466	0.031119
3.5	0.073576	3	0.042456	0.073576
4.5	0.134022	4	0.060446	0.134022
5.5	0.212458	5	0.078436	0.212458
6.5	0.308885	6	0.096426	0.308885
7.5	0.419766	7	0.110882	0.419766
8.5	0.523894	8	0.104127	0.523894
9.5	0.617732	9	0.093838	0.617732
10.5	0.70128	10	0.083549	0.70128
11.5	0.77454	11	0.073259	0.77454
12.5	0.83751	12	0.06297	0.83751
13.5	0.890191	13	0.052681	0.890191
14.5	0.932583	14	0.042392	0.932583
15.5	0.964685	15	0.032102	0.964685
16.5	0.986498	16	0.021813	0.986498
17.5	0.998022	17	0.011524	0.998022
18.12	1	18	0.001978	1
		Total	1	

Figure 5. Triangular Distribution Calculations CDF and Discretized PDF

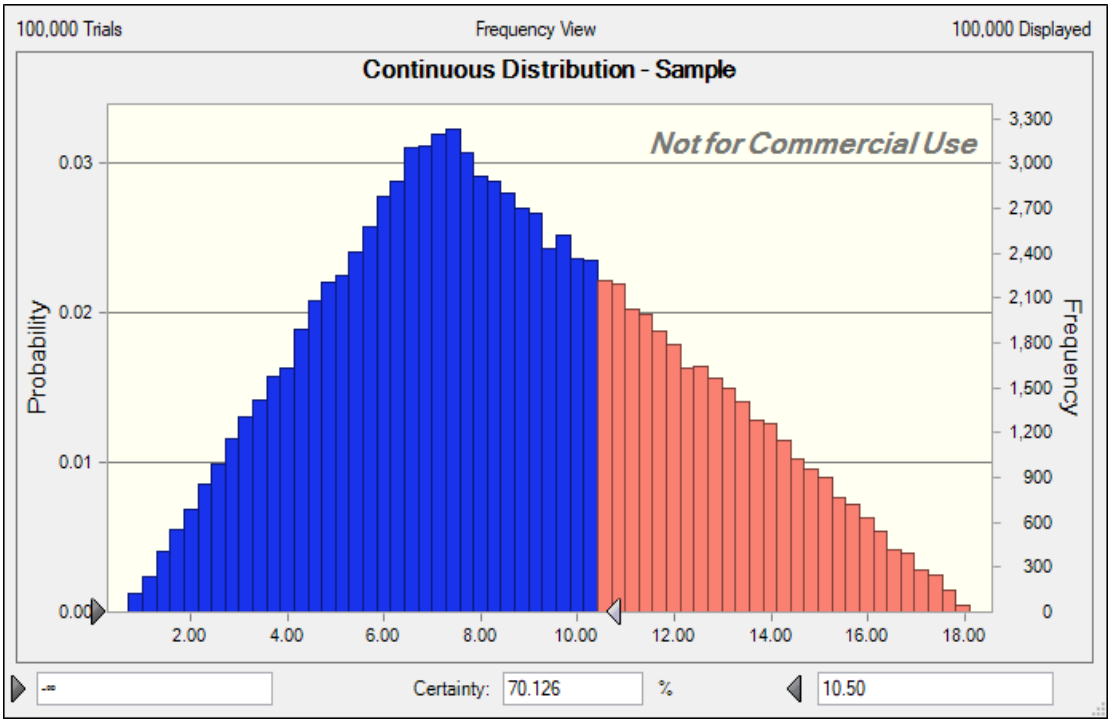

Figure 6. Continuous Distribution of CDF

When complete the graph can be viewed as seen in Figure 6 which also confirms the correct probability was calculated. Finally, seen in Figure 7 is the reverse cumulative frequency graph which helps visualize the frequency with which we expect the FOS-MADIS systems to be reduced if a funding reduction is encountered. It is important to note that the risk of a 10-system reduction being caused by the associated budget cut is not one that was directly provided by the input. Instead, it is derived from the 3 point estimate, and the assumption that probability varies in a linear way between those estimates (Triangular Distribution).

This was just one simple example of the methods that can be used to calculate risk probabilities for impact statements. With the variety of inputs from the MCPCs it will be necessary to use both continuous and discrete methods for these calculations, but the data will still be valuable and informative for either situation.

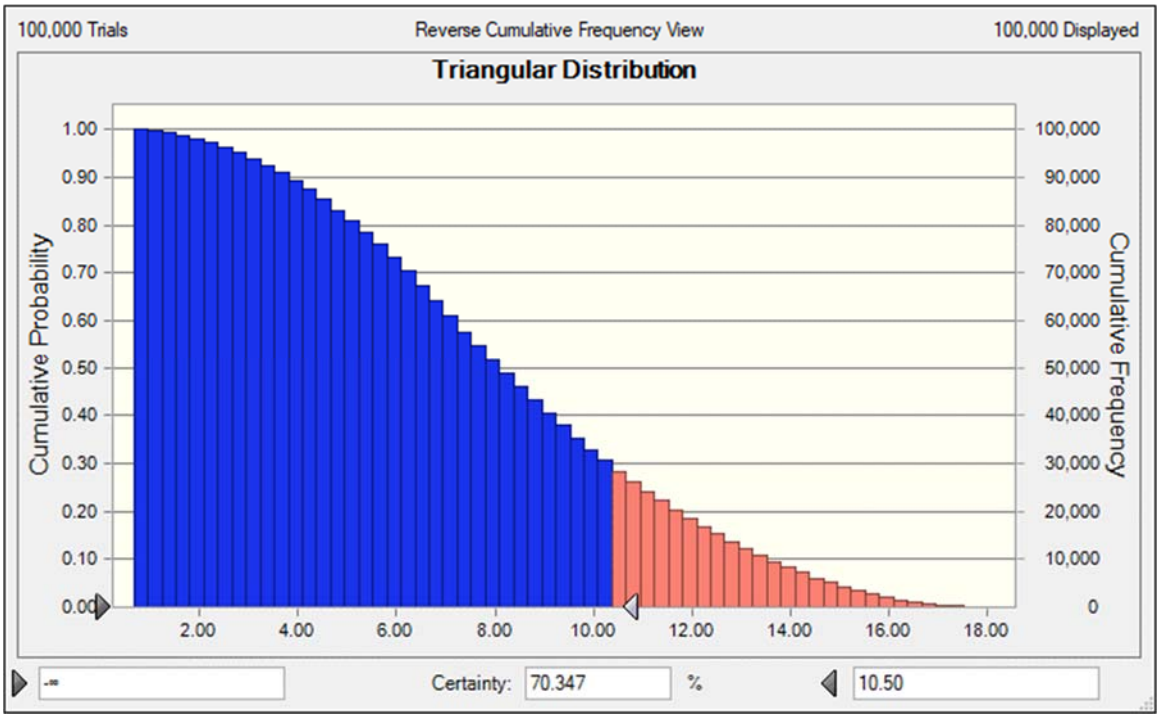

Figure 7. Triangular Distribution Reverse Cumulative Frequency Graph.

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